THE
RAILWAY GAZETTE
A Journal of Management, Engineering and Operation
INCORPORATING
The Railway Engineer · TRANSPORT · The Railway News
The Railway Times · Herapath's Railway Journal · RAILWAY RECORD.
RAILWAYS ILLUSTRATED · ESTABLISHED 1835 · The Railway Official Gazette

PUBLISHED EVERY FRIDAY
AT
33, TOTHILL STREET, WESTMINSTER, LONDON, S.W.1

Telegraphic Address: "TRAZETTE PARL., LONDON"
Telephone No.: VICTORIA 8836 (6 lines)

Annual subscription payable in advance and postage free:
British Isles and Abroad.....£2 5s. 0d.
Single Copies.....One Shilling
Registered at the General Post Office, London, as a Newspaper

VOL. 63. NO. 12 FRIDAY, SEPTEMBER 20, 1935

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ELECTRIC RAILWAY TRACTION

A Supplement illustrating and describing developments in Electric Railway Traction is presented with each copy of this week's issue.

Streamlined Trains

WITH the introduction on September 30 next of the London & North Eastern Railway Company's new high-speed streamlined train between London and Newcastle, yet another is added to the growing list of practical attempts to achieve ultra high-speed railway travelling economically. To Germany may be accorded the distinction of having inaugurated the vogue of streamlining with the high-speed Flying Hamburger first placed in regular service on May 15, 1933. Then, in a matter of weeks, France followed with the Bugatti railcar on the Etat, and America later with the Burlington Zephyr and the Union Pacific streamlined trains. All these were departures from recognised practice in more than streamlining, for they were all propelled by internal combustion engines. It was probably their advent that stirred the steam locomotive protagonist to make more comprehensive attempts than hitherto with that type of propulsion. Mr. Gresley's No. 10000 of 1929 has a certain amount of streamlining about it, and last March Mr. Collett, as an experiment, partially streamlined one of the G.W.R. "King" class locomotives; there have also been several other examples abroad. The first really thorough attempt at a streamlined steam train was represented by the Asia Express of the South Manchuria Railway last year, and since then there have been several others, notably the Hiawatha in America, the P.L.M. streamlined train in France, at least one in Germany, and now the Silver Jubilee of the L.N.E.R. Meantime, diesel and electric streamlined trains have been introduced in various countries, and it would seem as if railways generally were now well on the way to adopting streamlining in order to provide the public with much higher speeds of travel on land than they have hitherto enjoyed.

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Four Hundred Miles a Day

Professor William Lyon Phelps, of Yale University, has given an interview to the *Washington Post* on the pleasures of railway travel. In the course of his journeys he visited this country, of which he remarked: "England is so small, and the trains are so very fast, that one can take early breakfast, go by train 200 miles, spend the whole day at that destination, take the train back, and dine in the London hotel." The professor did not state how early he had breakfast or how late he had dinner, nor again how many hours he considered to constitute the "whole day," so we shall accept his encomiums in principle, without trying to enumerate the towns two hundred miles from London with a train service so swift and conveniently planned as to permit of such flying visits. His scope would, of course, be extended if he consented to take his meals on the train, but even then he would find certain notable places less than two hundred miles from London which can be visited more easily within the twelve hours by the half-day excursionist enjoying his three miles a penny than by the first class passenger at three-halfpence a mile.

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The Week's Traffics

A disappointing fall of £29,000 net in the traffics of the four group companies for the past week has reduced their aggregate net increase for the year to date to £785,000, which represents an increase of 0·74 per cent. on the corresponding 37 weeks of 1934. In the traffics for the past week the most hopeful feature is the increase of £11,000 in passenger train receipts on the Southern, but goods and coal are on the whole depressing. Passenger train traffics of the four companies together for the 37 weeks amount to £49,909,000, an increase of £1,169,000, or 2·40 per cent. Aggregate merchandise traffics for the year to date show a net decrease of £46,000 for the four companies together; the L.M.S.R. and Great Western show increases of £73,000 and £44,000, respectively, whereas the Southern is down £138,000 and the L.N.E.R. £25,000.

	37th Week				Year to date.	
	Pass., &c.	Goods. &c.	Coal, &c.	Total.	Inc. or Dec.	
	£	£	£	£	£	%
L.M.S.R.	− 6,000	+ 4,000	+ 3,000	+ 1,000	+ 481,000	+ 1·13
L.N.E.R.	− 6,000	− 9,000	−12,000	− 27,000	+ 48,000	+ 0·15
G.W.R.	+ 2,000	+ 2,000	−12,000	− 8,000	+ 124,000	+ 0·69
S.R.	+ 11,000	− 5,000	− 1,000	+ 5,000	+ 132,000	+ 0·91

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Northern Ireland Railways in 1934

Railways wholly in Northern Ireland had in 1934, as shown by the financial accounts and statistical returns supplied to us by the Ministry of Commerce, gross receipts from railway working of £505,736 comparing with £465,512 in 1933 and £574,902 in 1932. These railways include the Belfast & County Down, Bessbrook & Newry, Clogher Valley, and Northern Counties (L.M.S.). The year 1933 was, of course, an exceptionally bad one, because of the strike of over two months in the early part of that year. Expenditure was reduced from £613,561

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in 1932 to £565,202 in 1934, but there was a loss on railway working of £59,466 in 1934 compared with £38,659 in 1932, and £88,593 in 1933. Only the Belfast & County Down and the Bessbrook & Newry earned net receipts from railway working in 1934. Road transport, however, gave a profit of £9,843 on the Northern Counties and of £1,381 on the Belfast & County Down, and from the hotels department the Northern Counties secured £3,912 and the County Down £4,527. Railways partly in Northern Ireland include the County Donegal; Dundalk, Newry & Greenore; Great Northern; Londonderry & Lough Swilly; and Sligo, Leitrim & Northern Counties. As a whole they earned a profit of £20,890 on railway working, but this was entirely due to the £46,362 of the Great Northern. Passenger receipts on railways wholly in Northern Ireland have fallen only from £259,904 in 1932 to £256,633 in 1934, although the drop on the cross-border railways has been from £450,205 to £417,391. In other passenger train traffic the fall has been larger, *i.e.*, from £79,087 in 1932 to £67,906 in 1934 in Northern Ireland, and from £151,993 to £130,937 for cross-border lines. Goods train traffic has, however, been the chief sufferer, as it has dropped from £230,716 to £176,326 in Northern Ireland and from £661,062 to £513,344 on the cross-border railways.

* * * *

L.M.S.R. Locomotive Veterans

We have already referred to the preservation at St. Rollox works, Glasgow, of the former Caledonian Railway single No. 123, and we now learn that it is to be joined by another veteran—the Highland Railway 4-6-0 No. 103, of 1894, designed by Mr. D. Jones. They make an interesting pair in that, while No. 123 was the last single-driver to remain in regular main-line service in this country, No. 103 was the first engine of the 4-6-0 wheel arrangement to be put to work in Great Britain. There were fifteen engines in the class, all built by Sharp, Stewart and Company, and although primarily intended for goods service, they assisted in working the heavy passenger traffic during the tourist season. As well as being the first 4-6-0's they were the largest main-line engines then running. Efforts have been made to restore Nos. 123 and 103 as closely as possible to their original condition and the 4-6-0 has regained the type of louvred chimney at first fitted. Repainting has been carried out in Highland olive green, but although this is the more familiar livery it is not strictly accurate, as apple green was used for the Highland engines over a short period during which No. 103 was built. The Caledonian engine has been painted in its original blue.

* * * *

Ministry of Transport Railway Employment Inspector

The Ministry of Transport advertisement in the Official Notices on page 355 of our issue of August 30 was presumably a sequel to the death on July 14 of Mr. Scott Main. The position offered is, however, neither that of an assistant inspecting officer nor the minor office of sub-inspecting officer; the vacant appointment is of a railway employment inspector on the staff of the Chief Inspecting Officer of Railways. Of the two ranks first named, that of sub-inspector is the older. In 1893 there was an agitation for the Board of Trade to have accidents to railway servants inquired into in a similar manner to train accidents. The then President of the Board of Trade looked into the matter and found that he had no such powers. The Railway Regulation Act of the same year authorised the Board of Trade to inquire into cases of alleged excessive hours of duty, and in October, 1894, two practical railwaymen—Mr. J. J. Hornby and Mr. Amos Ford—were appointed for the purpose, and gradually took over inquiries into accidents to railway servants. Later Mr. Charles Campbell was added, and he is the only survivor of the trio; his one colleague today is Mr. W. Worthy Cooke. The assistant inspecting officers were appointed in 1901 as a result of the Railway Employment (Prevention of Accidents) Act, 1900. Mr. Scott Main was one and the other was Mr. J. H. Armytage, who retired owing to ill-health. The vacant position was later filled by Mr. J. L. M. Moore, and these two gentlemen have conducted inquiries into all serious accidents to the men. In 1918 Mr. Main was given the additional rank of Assistant to the Chief Inspecting Officer.

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Rule 234A.

In the editorial note in our issue of August 30, summarising the results of the inquiries into the more serious accidents to railway servants during the December, 1934, quarter, mention was made of the accident near Swindon on November 13 when three men working in the "four-foot" of the up line were killed. As the line was straight, and approaching trains could be seen three-quarters of a mile away, no look-out man was provided. A goods train had passed on the down line and its steam and smoke hid the view of the up line, but the men had failed to obey Rule 234A., and "at once move clear of all lines unless they can distinctly see that they are in a position of safety and in no danger from another train approaching them unobserved." The result was that the three men were killed, and in his report on the accident, Mr. Moore remarked that it was to be regretted that a rule which had such an important bearing on the safety of men working on the line did not at times receive the attention it deserved from those for whose safety it was intended. Mr. Moore concluded his report thus: "This is one of the rules which are read out periodically by the gangers to their gangs. Recent experience has shown that, even so, some men fail to appreciate its object and importance. Still further action is clearly needed to bring it home to the men concerned that they must stand aside on every occasion and as soon as their view along the line where they are working becomes obscured from any cause, and the companies are strongly recommended to give this matter their early and serious consideration."

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Lübeck-Büchen Railway Developments

The Lübeck-Büchen Railway, the largest private railway in Germany, is engaged on extensive plans for the reconditioning of permanent way, improvement of signalling, and reorganisation of shunting in order to make possible accelerated passenger and goods services. The expenditure on these works during the current year is expected to exceed 2,500,000 RM. (£125,000 at par). Track renewals are in progress on the Hamburg-Lübeck, Lübeck-Travemünde, and Lübeck-Ratzeburg lines. According to *Hamburger Nachrichten*, the main line is to be given a 12-in. lift on new ballast from Hamburg to Lübeck, the old gravel ballast being thrown out. Some 85,000 tons of stone ballast are being brought to Lübeck by river and sea from the Rhineland. Curves are to be re-aligned and station approaches improved, eliminating many speed restrictions. Two-aspect ("proceed" and "caution") distant signals on the Hamburg-Lübeck line are to be replaced by three-aspect signals providing also a "reduced speed" indication, and like those on the German State Railway described in our issue of November 17, 1933, the new distant signals are to be

set 1,000 m. (1,094 yd.) in the rear of the home signals, instead of 700 m. (766 yd.) as heretofore. Lock-and-block working is being substituted for plain block telegraph between Lübeck and Travemünde, and mechanical signalling is being replaced by all-electric at Rhalstedt. Other improvements include the construction of a heavier bridge across the Elbe-Trave canal at Genin, and the provision of small locomotives (80 h.p. motor) for marshalling purposes at intermediate stations between Hamburg and Lübeck. A new station, Wandsbek Ost, will serve the growing communities of Tronndorf and Lohe.

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In Praise of Air-Conditioning

The President of the Illinois Central Railway, Mr. L. A. Downs, publicly stated on a recent occasion that the greatest development in railway passenger service for many years is undoubtedly the air-conditioning of passenger vehicles. "It is," he said, "an almost miraculous improvement, which with the arrival of summer impresses itself indelibly upon the consciousness of the travelling public." Air-conditioning makes the railway traveller comfortably independent of the weather. Inside the coach it is always pleasantly the same, no matter what the conditions outside may be; whether the air be hot or cold, wet or dry, clean or dirty, does not affect the passengers. The dust, cinders, noise and all the earlier discomforts of travelling by train are eradicated, and coupled with higher speeds and lower fares air-conditioning has improved rail journeys out of knowledge. Mechanically considered, the achievement is the remarkable one of changing, cleaning, cooling (or heating), and regulating the humidity of the 4,500 cu. ft. of air in the average car once every two minutes. In the series of articles we have published from the pen of Mr. Stuart Miall, full descriptions have been given of the various types of equipment which mixes car air with outside air, filters the mixture, cools or heats it, whilst at the same time governing its moisture content, and blows it gently into the car through ducts scientifically designed and located to prevent any possible draught. Thermostatic control governs this mechanism and air-tight windows and doors maintain its results and at the same time eliminate noise and dirt. More than 6,000 passenger vehicles are already equipped with the apparatus on the American railways and all sleeping cars are likewise air-conditioned, as also are the dining and lounge cars on many trains.

* * * *

Route Indicators in Speed Signalling

The respective merits of route and speed signalling at junctions have been argued at length on many occasions by signal engineers. The subject is by no means as simple as it appears, and the attempt to be perfectly logical in applying either principle is very liable to lead to unexpected obstacles. In countries such as Great Britain, where the bracket type of signal has long prevailed, there has been as yet little disposition to make much radical change, but in those where the signal aspects were not so well adapted to the indication of routes the speed principle has gained much ground, first in the United States, where it may almost be said to be standard, and in recent years in some European countries, such as France and Germany, where the bracket signal was unknown. In the two last, however, it is felt that at junctions where the same permissible speed applies to more than one direction, one signal is not sufficient and some supplementary route indication is desirable. In France, therefore, the separate *indicateurs de direction* will be retained in those cases. In Germany it has been decided to show a luminous sign at the home signal in the form of the initial letter of the principal destination on the route set up and to repeat this on another indicator 50 m. (54·7 yd.) in advance of the distant signal. Presumably the traffic department has asked for this combination of route and speed signalling, being unwilling to abandon the indication of which route is set up—at least in certain cases—where speed indications alone do not permit of the driver deducing it from them.

* * * *

Roller Bearing Locomotive Rods

Very little progress has been made as yet in the application of anti-friction bearings to the connecting and side rods of locomotives. This is not in any measure due to difficulty in manufacturing bearings which will stand up to the loads to be carried, but rather to the increased weight and size of the application. Nevertheless the matter is receiving increasing attention, especially abroad, and we understand that Timken bearings have been recently applied to the crossheads and all rods, as well as to all axles, of a 4-6-2 type locomotive on the Pennsylvania Railroad. This locomotive has now been in service for some months and is reported to be giving perfectly satisfactory results. The bearings used are of a special design and alloy steel rods have been evolved for use with them. In addition, the New York Central has recently placed an order for side and connecting rods with Timken bearings for the streamlined 4-8-4 locomotive *Commodore Vanderbilt*, which already has Timken bearings on all axles, including the tender. Roller bearings have been applied in a few cases to side rods of small diesel and steam locomotives, and are reported to have given entire satisfaction. There is considerable scope for the use of anti-friction bearings in the valve motion of steam locomotives and some progress with ball and parallel roller bearings has already been made in this direction. Apart from savings in maintenance and lubrication, the principal advantage here is in the maintenance of the valve timing as originally set.

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High Speeds and Lubrication

Nowadays, when higher speeds, more often referred to as "improved schedules," are becoming the vogue on railways both in this country and abroad, the tendency is to regard the matter primarily from the standpoint of safety in operation and endurance of material under conditions of increased strain. Sustained speeds of from 75 to 90 m.p.h. for comparatively lengthy periods must, as a matter of course, subject the locomotive to a greater test than when lower speeds rule—a test both of its ability to perform the task demanded of it, and to stand up to whatever extra strain may be imposed by the circumstances. There is, moreover, another aspect of the matter to be considered, and one that requires the closest attention, namely the all-important question of lubrication. These long and very fast runs induce much the same conditions as arise wherever machinery is run continuously at high speeds, and it is fundamentally important in such circumstances to improve lubricating methods. The lubricant itself, as well as the apparatus used for feeding it to the parts affected, must be entirely adequate and the advances made in this direction during several years past, although designed in the main to meet normal needs, may be confidently relied upon to provide for the more strenuous conditions now involved. It seems certain that it is the provision of efficient lubricating systems which will impose one of the principal tests arising from the much increased speeds.

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Tanganyika Railways

THE Tanganyika Railways consisted at December 31, 1934, of 1,376¼ miles of metre gauge line in two main sections, without physical connection with each other. On the Central Railway the main line of 775 miles runs from the port of Dar-es-Salaam on the Indian Ocean through Manyoni and Tabora to Kigoma on Lake Tanganyika, and a branch of 235½ miles leads from Tabora northwards to Mwanza on Lake Victoria. Another part of the Central system is the Manyoni-Kinyangiri branch of 93½ miles, the last 22 miles of which were opened in April, 1934. The Northern (or Tanga) Railway of 272¼ miles proceeds from the port of Tanga, on the Indian Ocean, to Moshi and Arusha, and makes a connection with the Kenya & Uganda Railways by the Kahe-Voi link. Steamer services on Lake Tanganyika, wharves at Dar-es-Salaam, Tanga, Kigoma, and Mwanza, and 500 miles of coast line are under the same administration as the railways. Of a total of 111 stations, 39 are closed and no staff is provided for them. Traffic is, however, accepted at the closed stations by the guards of trains.

The report received this week from the General Manager, Colonel G. A. P. Maxwell, C.M.G., covers the full twelve months of 1934, and exact comparisons can therefore be made with the same period of 1933. At the end of 1932 the closing date of the railway financial year was altered from March 31 to December 31 to accord with the accounts of the Territory. During the year under review the large decrease in traffic to and from the Belgian Congo continued, but there was a substantial increase in most other kinds of goods traffic. Native production of cotton and grains continued to increase, but the ground nut crop was a partial failure. As mentioned in the 1933 report many revised classifications were brought into force on January 1, 1934, as a result of the report of Mr. Roger Gibb. Except where otherwise stated, the figures in the accompanying table refer to railway operations only:—

	1934	1933
Passengers	221,295	245,435
Tons, revenue earning	220,065	198,353
Ton-miles ,,	43,672,558	41,972,129
Train-miles ,,	592,285	617,903
Average receipt per ton	36s.	35s.
Operating ratio, all services	64·71 per cent.	66·40 per cent.
	£	£
Coaching revenue	76,542	80,335
Goods revenue	397,978	349,158
Gross receipts	505,229	473,907
Expenses	331,705	319,639
Net earnings	173,524	154,268
Other services (net)	26,141	24,496
Interest charges, all services	323,919	285,342
Net loss ,, ,,	124,254	112,635

An ordinance entitled Carriage of Goods by Motor (Prohibition) Ordinance was brought into force on April 1, 1934, which prohibits the carriage of goods for reward by motor vehicle between all points served by the railways. Certain contraventions of the ordinance have occurred, but the measure in general has prevented any serious competition by road transport in the carriage of goods. By means of the new Sentinel railcar service between Tanga and Mombo the passenger traffic decrease on that section, which had prevailed since 1930, has been definitely arrested. Two of these cars are now in use, and the provision of a third will be imperative in the near future. Their financial results are in themselves highly satisfactory and they have also enabled important savings in train mileage to be effected. The Sentinel shunting engines of which there are seven in use on the Central line and one on the Tanga line are giving excellent and economical service, and similar satisfaction has been found with the three Garratt engines in regular service in the Dar-es-Salaam-Morogoro section. Notwithstanding the continued low expenditure on maintenance the lines are still in good running order; but replacement of fittings and points and crossings is overdue and will have to be arranged for in 1936.

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London-Newcastle in Four Hours

THE fastest long-distance train in the world is to be introduced by the London & North Eastern Railway on September 30, between London (King's Cross) and Newcastle. The distance of 268 miles will, as already announced in these columns, be covered in the level four hours, including an intermediate stop at Darlington, and when the nature of the road is taken into account and due regard has been paid to the speed restrictions imposed at various points, particularly through Peterborough, Selby, and York, where reductions to 10, 30, and 15 m.p.h. respectively are laid down, it will be recognised that this is no mean performance. No risks of excessive speed over restrictions are to be taken, for the locomotives are equipped with Flaman automatic speed indicators and recorders. Obviously a working of this character would be difficult of achievement with the ordinary types of rolling stock and train loadings, and in order that punctuality shall be maintained and the reputation of the service, in that and other respects, upheld, it is advisable that such a train should be of a limited character and of special composition. The new train, named *The Silver Jubilee* in celebration of H.M. King George's 25 years of reign, is composed of seven vehicles assembled in three units, namely, an articulated two-coach section at front and rear, with a triple set, also articulated, and comprising first and third class restaurant cars and kitchen car, and with this train, the tare weight of which is approximately 220 tons, the schedule provides for an overall speed of 67·07 m.p.h. For the 232 miles between Darlington and London 198 minutes only are allowed, giving an average speed of 70·4 m.p.h., the fastest scheduled start to stop run in the world for a distance of over 200 miles. An analysis of the timings as set forth on another page of this issue will show that high speed uphill is the feature of the schedule, and it is not anticipated that it will be necessary to run at extra high speeds on the falling gradients. The train will be hauled by a streamlined 4-6-2 locomotive and there are to be four engines of this class, all of them built at the company's works at Doncaster.

Mr. H. N. Gresley, the Chief Mechanical Engineer, has given much thought to the question of streamlining, and has produced what, in our opinion, should prove to be a practical and successful application of the principles involved. As the illustrations of the engine reproduced in this issue show, the front end takes the form of a horizontal wedge, causing the upward rising current of air to sweep past the chimney and along the boiler barrel top, and by its velocity assist in carrying the steam and smoke clear over the cab, besides avoiding lateral displacement of the atmosphere. The running boards are given the form of an aerofoil for the same reason. It will be further noticed that the curvature at the front is continued to a point immediately at the rear of the chimney, whence the boiler tapers for a further distance. Thus if a parallel line be drawn from the top of the cab to that of the chimney it will be seen at once that a wedge-shaped air space is formed above the boiler for some distance behind the chimney and this allows the air to get well underneath the steam and smoke and drive them upwards, a

process which cannot be so thoroughly effected where the top of the boiler is parallel throughout. The chimney itself is of special formation, and the front of the cab shaped as a prow which further assists in reducing the effect of wind resistance. It will thus be seen that there are no pockets or extuberances either to trap the air or aggravate the resistance met with. There are, we know, among those competent to speak on locomotive subjects, some who are doubtful almost to the point of total disbelief regarding the efficacy of streamlining locomotives and railway vehicles. It is possible that certain among them judge the matter from an academic rather than the practical standpoint, but such are presumably ready to revise their views in face of accomplished facts of undisputed value. It remains to be seen what measure of success the form of streamlining adopted on the L.N.E.R. achieves in actual practice, and the results may and, we think, will be sufficient to allay many of the doubts now held in many quarters with regard to this important point. Whilst in these new locomotives Mr. Gresley has adhered to his usual three-cylinder single expansion arrangement, the diameter of the cylinders has been slightly reduced and the boiler pressure increased to 250 lb. per sq. in., the result of the latter being an important augmentation of the tractive effort which now stands at 35,455 lb. as compared with the 32,909 lb. of the Super-Pacifics, with boilers pressed to 220 lb. An improved form of fire grate has been introduced, and the firebox incorporates a combustion chamber of large proportions. Our inspection of the boiler and its components at the Doncaster works when the first one was completed, left us with a most favourable impression of the general excellence of the boiler work there carried out, the interior firebox in particular being a fine example of copper firebox design and construction. The front end also has special features calculated to improve the boiler performance and take an important part in the general scheme of streamlined formation, whilst it would, we think, be difficult to improve upon the footplate arrangements and particularly upon the measures taken to ensure additional comfort and convenience for the enginemen. Each pair of coupled wheels carries a load of 22 tons, giving 66 tons of adhesion in all.

The train itself represents a striking example of modern passenger coaching stock and we would draw special attention to some general aspects of the assembly. The total weight of the train is, as previously stated, 220 tons odd, distributed as seen in the diagram drawing of the train reproduced on page 460. The general appearance of the train is effective, the coaches being finished in aluminium with stainless steel facias and beadings, whilst the interior arrangements present a sense of comfort and restfulness. The spaces between the articulated ends of the vehicles are closed in by means of rubber sheeting with aluminium finish, whilst, in order further to reduce the air resistance, a skirting is fitted between the bogies extending from the bottom of the body to within 10½ in. of the rail. Measures have been taken to deaden the noise to be anticipated when running at high speeds. Large side windows are fitted and some beautiful effects have been produced in the interior wood panelling, together with restrained but effective lighting arrangements. A train of this character would be considered incomplete unless equipped with an efficient ventilating and heating system, and fresh filtered air is forced into the compartments through outlets in the floor level whilst in cold weather the air is heated to the required temperature according to the setting of a special compensated thermostat. Passengers on the train will enjoy the combined advantages of unusually high speed travel and the most comfortable surroundings. The introduction of the new schedules and the formation of the locomotive and its train may each be said to be worthy of the other, and will, we think, be appreciated at their full value by the travelling public.

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Winter Train Services

A REVIEW of the train service changes which have taken place this summer, or are about to take place with the introduction of the winter timetable, as set out on page 462 of this issue, reveals that 1935 will have shown the most material improvement in British travel facilities that has taken place since the momentous accelerations carried out by the L.M.S. and L.N.E. companies in 1932. In particular, the duration of the best regular journeys over many main lines will have been reduced to lower figures than at any previous period of our railway history. Most notable of all, the Silver Jubilee service of the L.N.E.R. will cut the best winter London-Newcastle schedule by 67 min.—from 5 hr. 7 min. to 4 hr.—and will introduce the world's first railway schedule at over 70 m.p.h. for a non-stop run exceeding 200 miles in length. The new 3½-hr. Pullman service between King's Cross and Hull will reduce the best previous down journey time by 22 min., and will deduct 32 min. from the fastest present up journey. On the Great Western Railway new standards of long-distance speed have been established by the new Bristolian service, which for the first time on record brings Bristol within 1¾ hr. of the Metropolis. In conjunction with the L.M.S.R. also, the G.W.R. has established valuable new cross-country facilities, morning and evening, between Swansea and Manchester, which represent cuts in time averaging over an hour below the figures previously customary over the whole course. The principal L.M.S.R. achievement, more modest in extent but applying daily to seven trains, has been to reduce the historic two-hour schedule between Euston and Birmingham to 1 hr. 55 min. To this acceleration movement the Southern Railway has added its quota, by reducing the best Waterloo-Portsmouth times to 90 min., and those between Waterloo and Bournemouth to 118 min., both of which are faster than ever before scheduled. There has also been the vast general improvement brought about by electrification in the services between London and Eastbourne, as well as along the coast route between Brighton and Lewes, Seaford, Eastbourne, Bexhill, and Hastings.

There are other features of British railway working during the past summer which afford material for congratulation. It is beyond dispute that punctuality in general has been at a considerably higher level than in the years immediately previous. This has been partly due to the availability of more ample locomotive power, partly—especially at week-ends—to the provision of additional mileage by the regular division of what in other years had been unwieldy train formations, and partly, facilitated by these train divisons, to the running of many of the additional trains over great distances without any booked stops intermediately, which tended greatly to reduce station congestion. Another valuable contributory towards improved punctuality, which we have never ceased to advocate in these columns, has been the encouragement to engine crews, either actively or tacitly on the part of managements, to recover lost time in running when this is reasonably and safely possible. The "On Time" campaign of the L.M.S.R. has, without dispute, achieved a great deal in this direction, and this punctuality propaganda is worthy of national adoption in view of the public benefit that it confers.

Nevertheless, it would be idle to contend that finality in timetable improvement has been reached. The North of Scotland is still further from London in point of time

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than it was forty years ago; and the owner of a private car can easily cut below the times of long-distance trains through the heart of the Highlands and farther north without any excessively speedy use of the public highways. The Night Scot from Euston to Glasgow today requires 9 hr. 50 min. for its journey as compared with eight hours for many years up to the war period. Between London and Sheffield the best times by three routes are all now slower than they were a quarter-of-a-century ago. The London-Birmingham service of the Great Western Railway is inferior in both speed and frequency to what it was before the war. The general average speed of all express trains between St. Pancras and Manchester, Leeds, and Bradford is less than was in 1910. Electrification, notwithstanding the increased frequency and average speed that is brought about in the Southern Railway services to and from the South Coast, has in no case reduced the fastest time for which speed was responsible before the change took place. Cross-country services, such as that from Bournemouth to Newcastle, have in some cases been so decelerated from pre-war standards that the through passenger prefers the much quicker course of travelling by way of London. A Mecca of invalids such as Harrogate, on the other hand, though admirably linked with London, is consderably worse off in regard to general through coach facilities than formerly, all the through carriages from the Midland cities of Leicester, Nottingham, and Sheffield having been withdrawn. Despite the accelerations which have taken place, a city of the size of Grimsby has no quicker rail communication with London than is represented by an average speed of 43½ m.p.h., and the best time between London and Norwich as yet has only reached an overall speed of 47 m.p.h., while the less said of cross-country connections with these centres of population the better. There is a tendency, also, to concentrate on the acceleration of spectacular trains, and on the intermediate adjustment of running times of other trains in such a way as to produce additional mile-a-minute runs without any overall gain, for publicity purposes, rather than to attend to the general improvement of main line passenger train services.

During recent years both Germany and the United States have afforded striking examples of the possibilities of complete timetable revision, with a marked rise in the general level of speed. The changes in the U.S.A. during the past two years, most of which have been referred to in our columns, have been astonishing indeed, and as yet there are no signs of abatement in the flood tide of American acceleration. The latest news is that the overall times of the Commodore Vanderbilt of the New York Central Lines, and the Liberty Limited of the Pennsylvania, have both come down to 17 hr. 40 min. on their eastward runs from Chicago to New York. The significance of this is not merely the cut of 2 hr. 20 min. below the time which for so many years was the exclusive property of the famous Twentieth Century and Broadway Limited expresses, but that to both the former trains "coach" passengers are admitted, without supplementary fare or even Pullman surcharge. Obviously the "Century" and the "Broadway"—the only "extra fare" trains now remaining on the service—will not long be content with an advantage of merely 40 min. in time over other New York-Chicago trains, and we understand that both these flyers, which in five years have cut their running times from 20 hr. to 17 hr., are to be further accelerated in October. But this is not merely a case of speeding-up two spectacular trains; it is because the *whole* New York-Chicago service has been accelerated to such an extent that these two famous expresses have to be further hastened on their journeys, in order to maintain their prestige.

PUBLICATIONS RECEIVED

The Railway Handbook, 1935-36. London: The Railway Publishing Co. Ltd., 33, Tothill Street, Westminster, S.W.1. 8½ in. × 5½ in. 96 pp. Price 2s. 6d.—"The Railway Handbook" for the present year maintains and even enhances the reputation for comprehensiveness established by its first issue in 1934. The data, except where international comparisons are concerned, are confined mainly to Great Britain and Ireland, and present a statistical summary of operation and equipment on the systems of the two countries according to the latest published information. The survey deals not only with the important groups, but with all the smaller companies, recording their addresses, gauge, types of rolling stock, and dates of opening. The last-named particulars have been considerably amplified since the previous edition. The specific information relating to the various companies is followed by general tables showing longest tunnels, highest altitudes, longest non-stop runs and fastest schedules, numbers and remuneration of staff, noteworthy accidents and records of immunity therefrom, and so on. The table of the world's railway mileage has been set out in a new and more useful form in accordance with information received in reply to a specially prepared questionnaire, and shows the date of opening the first line in almost all the countries individually listed. The notes on motive power, permanent way, signalling, and railway enterprise, service and achievements in general have been retained with suitable revision. All who require swift and reliable reference to railway data will find the handbook indispensable.

Duplicate Busbar Switchgear.—We have received from Switchgear & Cowans Limited, Elsinore Road, Old Trafford, Manchester, an illustrated catalogue section describing the firm's system of duplicate busbar switchgear. This is designed to afford the flexibility necessary to assure minimum interruption of supply during extensions or alterations to the distribution equipment. The apparatus works on the "off load" system, in which the changeover is made after isolating the circuit-breaker, the complete breaker being moved into a position corresponding with the desired set of busbars and the main terminals raised into contact with the appropriate busbar terminals. This method is an effective safeguard against mistakes of operation. The switchgear is supplied in self-contained metal-clad units, any number of which can be grouped according to the circuits it is desired to control. The neat and sturdy appearance of the equipment and its individual parts is exemplified in the illustrations.

Volume Fans.—Electric fans, with direct or alternating current motors, and belt-driven units, are described in this useful catalogue published by James Keith & Blackman Co. Ltd., 27, Farringdon Avenue, E.C.4. Detailed tables are included to assist in the selection of equipment for given circumstances. The electric motors are particularly silent in operation, and are supplied in protected or totally-enclosed types for situations where the fans have to work in an impure atmosphere. Many standard variations of construction can be specified when ordering, so that the direction of running and, in the case of belt-driven models, the location of the main and guide pulleys, can be varied according to customers' requirements. Among the purposes to which these Blackman fans can be applied are drying, dust, fume and steam removal, cellulose operations, and refrigeration. The firm manufactures its own starting and regulating equipment for use with the electric fans.

THE SCRAP HEAP

Q.—" I heard a man tell another the other day that some railway engines abroad were ' stoker fired.' I thought *all* engines had stokers."

A.—" So they do, but they call them firemen here and stokers abroad."

* * *

The first railway through Dartford was opened in 1849. The railway directors had a great deal of opposition to their Bill in Parliament in 1846 and amongst others from John and Edward Hall, for the first proposed line ran right through their foundry as shown in a plan still existing at the works. Edward Hall succeeded in securing the concession that the line should not be less than a certain number of yards north of any of Hall's existing buildings. It is said that Hall hurried back to Dartford and very quickly ran up a new " existing " building. However this may be, the line was eventually built a good deal farther north than the first proposal.—*From " J. and E. Hall Limited, 1785 to 1935 " by Everard Hesketh.*

* * *

AN UNSOLICITED TESTIMONIAL

Following the introduction of a steel covered train (described in our issue of August 16) for Dublin-Cork services, the Great Southern Railways, Ireland, has received the following appreciation from a satisfied passenger:—

" I have now inspected your steel creation. It made me feel like the Queen of Sheba before Solomon. I would say of it that it is what the gods will be building in their Mount Olympus shops for their Pearly Gate Flyer on the Southern Railways of the New Jerusalem. The whole ensemble is a dream, the chromium plated gadgets, fixtures and fittings an inspiration. If prayers will do you any good, those of the cleaning staff, as a result of the chromium, ought to ensure you a clear road into the terminus above. The sight of this lovely conception standing at rest in the gloom of the terminus . . . . well, to quote Shakespeare, it made ' that vault a feasting presence full of light.' The dining car is a gastronomical delight. The kitchen a marvel of culinary compactness. I am devoutly glad that you have been mercifully preserved from the snare of the streamliner.

" I very much regret that I was unable to inspect the running department, the platform being in the way. I feel sure that nothing but steel springs and the best of steel wheels could be used, and that the latter were very carefully tested for circularity before being used. Had I been consulted, I would have suggested a few steel engravings of Killarney, &c., in steel frames, on the interior, anterior, and posterior walls, and that the upholstery scheme be done in steel wool. The presence of this shrine upon your road cannot fail to arouse great travelling fervour in the heart of the people of this country; with, I trust, beneficial results to the coffers of the company. At any rate, the night I entered the Presence it was very full.

" *Si monumentum requiris circumspice*: which means, steal a glimpse at it, if you want to see what Inchicore can do."

* * *

THE COST OF FREE TRAVEL.

Quite apart from the loss in fares, tramps who steal illicit rides on American goods trains are a source of expense to the companies they favour with their attentions. Mr. R. S. Mitchell, Chief Special Agent of the Missouri Pacific Railways, states that his company has already spent more than £10,000 this year on hospital treatment for tramps who have been injured in the course of their exploits, on burying them, or on settling claims arising from their activities. Since January, 1933, 269 trespassers have been killed on the Missouri Pacific alone while leaving or boarding moving wagons.

One Hundred Years Ago

Extracts from the September, 1835, issue of " The Railway Magazine " (afterwards " Herapath's Railway Journal ") and the oldest constituent of THE RAILWAY GAZETTE

The London and Southampton Railway, which is already authorised by Act of Parliament—the capital fully subscribed—the works commenced and in a state of great forwardness, pursues the most direct line from London towards Bristol for forty-four miles, leaving only *seventy-three* miles of New Line to be made from Basing, in order to complete a Railway between London and Bristol. . . . The Great Western Railway adopts four miles of the London and Birmingham Railway out of London, and yet requires one hundred and fifteen miles of New Line, making a total length of *one hundred and nineteen miles* from Bristol to London.

BRISTOL AND GLOUCESTER RAILWAY.—This Railway (from Bristol to the Great Westerlegh coalfield), was opened on August 6. It is nine miles long; and the cuttings and embankments are supposed to be greater than on any railway of similar extent which has yet been formed . . . . . The Act was obtained in June, 1828, and the works were commenced in June, 1829.

THE GREAT NORTHERN RAILWAY FROM LONDON TO YORK, &c.—We regret to find there is a division of interests respecting this great and national undertaking. We are informed that there are now two or three companies desirous of effecting the project, but differing as to the manner in which it should be done. Two of these companies adopt lines direct from London to York . . . . . There is also another line projected, called the Midland Railway, by way of Birmingham, &c.

MR. OGLE ON STEAM BOILERS

As a proof of what I have said of their safety (their efficiency is proved by their propelling carriages at great velocities) of the boilers used by me, if any steam-boat proprietors will undertake to put one into any vessel, I will make a boiler red hot, stand on the top and inject cold water into it. [We trust Mr. Ogle will find no one so barbarous as to take him at his word, and that in the event of his being required to prove the safety of his own boiler, it will be thought sufficient that he should stand *over* it.—ED. *Railway Magazine*].—*Extract from a letter to " The Times " (quoted in " The Railway Magazine ") by Mr. Ogle, designer of a high-pressure boiler for steam carriages, and an editorial comment thereon.*

RAILWAY TRAFFICS

Mr. Editor,

Having in a former number of your useful publication given you a few hints on the subject of the Greenwich Railway, I am induced to add the following calculation, made up by my little boy, which may be instructive and not displeasing to some of your readers.

I am Sir, your obedient servant,
A Shareholder

24 passengers
every ¼ hour

96 passengers per hour.
12 hours in each day.

1,152 passengers per day.
12 coaches

13,824 passengers per day.
2 up and down

2)27,648 passengers at 6d. each.

20)1,382, 4 shillings per day.

£691 4s. per day
365 days in the year.

£252,215
73 4s. per day for 365 days

£252,288 per annum.

[We have inserted this communication at the request of our reader, but we cannot in future notice such calculations.—ED. *Railway Magazine.*]

GRAND JUNCTION RAILWAY.—The first permanent rail on this line was laid yesterday week, at Bird's Wood, near Preston Brook, by Mr. Alfred Ice and Mr. Tate, assistants to Mr Locke.—*Leeds Mercury, August* 15.

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OVERSEAS RAILWAY AFFAIRS

(From our special correspondents)

INDIA

Holiday Travel Concessions

Most of the railways are offering liberal concessions for travel during the holiday period, and expect to handle a heavy holiday traffic.

The Bengal-Nagpur Railway has again taken the lead in offering the maximum holiday concession in post war years. For first, second and intermediate class passengers, return tickets are available for a fare and a quarter, while third class return tickets will be sold for a fare and a half. First and second class holiday passengers may have their motor cars transported in both the outward and the return directions at the cost of only a single journey charge.

Railway Services Disorganised by Floods

Heavy rainfall has been responsible for floods and damage to permanent way in various parts of the country. The Punjab was the first to suffer and there most of the rivers, notably the Ravi, and Chenab, were in high flood on August 10. Stretches of line were inundated and traffic on the Kangra Valley Railway had to be suspended till August 12, when passenger traffic was restored with transhipment. In Bengal, a flood occurred in the Damodar River and the protective embankments were breached in several places, causing the inundation of the surrounding areas. The East Indian Railway lines in the neighbourhood were unaffected, but the light railways, the Bengal Provincial Railway and the Bankura-Damodar River Railway, were breached. Burdwan town was several feet under water and refugees gathered in numbers on the railway overbridge. Further up on the Grand Chord section of the East Indian Railway, the line between Islampur and Sone-East-Bank was rendered unsafe for the passage of trains, necessitating the immediate diversion of through mail and express trains to the Gaya-Patna route. Later the mail and express services scheduled to run over the Grand Chord were diverted to the main line. Arrangements were made to run connecting trains between Asansol and Gaya. The Jubbulpore section of the G.I.P. Railway was also breached. The Bombay-Howrah mail train was saved from a serious disaster on August 14 by the vigilance of a gatekeeper on the Satna-Allahabad section, who pulled up the train on the suspicion that the line beyond was unsafe. Engineers confirmed this view and the train was diverted to Katni and the B.N.R. route. The Howrah-Bombay train was also diverted to the route via Jhansi, and, pending the completion of the repairs, the Howrah-Bombay mail service via the East Indian Railway has followed the Jhansi route. The floods are now subsiding, but acute distress prevails in the areas affected.

Lower Class Dining Cars

From mid-August the East Indian Railway is running an Indian restaurant car attached to the 17 up and 18 down expresses between Howrah and Saharanpur: these cars are provided with separate compartments for orthodox and unorthodox passengers.

New Railway Bridge in Assam

The Government of Bengal has given its approval to the construction by the Assam Bengal Railway of a bridge over the River Megna at Bhairab. The Railway Board has already approved the scheme and allotted a sum of Rs. 8 lakhs for expenditure during the year 1935 36. The bridge is estimated to cost Rs. 60 lakhs. Preliminary work has been begun.

Rail Fares Reduced

Following the success achieved by the Madras & Southern Mahratta Railway in combating road competition on the Bezwada-Masulipatam and other sections, already mentioned in these columns, the administration has now decided to reduce substantially the third class fares over the Nidadavolu-Narsapur section. The introduction of diesel-electric coaches on the Coconada-Kotipalli branch is considered likely to deal effectively with road motor competition. Both these sections of the railway traverse rich and populous areas where intense bus competition prevails.

Exhibition Trains

The Puja Baza Special—an annual feature of the Eastern Bengal Railway—is on tour. The itinerary provides for visits to 19 broad gauge and 13 metre gauge stations. An open air cinema show will be given at each station for which a popular film in Bengali has been specially obtained.

A Madras company is organising a National Industries Exhibition train to tour over 4,000 miles on the metre gauge sections of the Madras and Southern Mahratta, the Mysore, the South Indian and the Nizam's State Railways. It is proposed that only Indian manufactures shall be exhibited.

New Howrah Bridge

It is understood that the consulting engineers of the Calcutta Port Commissioners have completed the detailed examination of the tenders submitted for the construction of the new Howrah bridge by British, Continental and Indian firms. The Commissioners will make a final decision on the tenders very shortly. In the meantime persistent rumours that the contract will be placed outside India have drawn representations from commercial bodies urging the claims of the Indian engineering industry, and that the acceptance of the Indian tender would benefit railway revenues by the transport of about 26,000 tons of steel required for the bridge, as well as raw materials necessary for the manufacture of this amount of steel.

SOUTH AFRICA

Catering Services

Mr. G. E. Chittenden, Director of the Publicity and Travel Bureau in London, has recently completed an investigation into the catering services on the South African Railways, having previously undertaken a tour of the United Kingdom, Canada and the United States of America studying the conditions on those railways.

In his report, Mr. Chittenden expresses the view that in essential quality and general standards of service the catering and sleeping facilities in South Africa not only compare favourably with those of overseas railways but are in many respects superior. Furthermore, if the standard of our services be analysed on the basis of the relative charges for similar services in other countries, then indubitably the South African Administration is providing the travelling public with very good value. With a view to the maintenance of, and if possible the improvement of this standard of excellence already achieved, Mr. Chittenden has recommended that closer personal contact between the Catering Manager and the General Manager is desirable and he suggests that the office of the Catering Manager should be removed from Braamfontein to Headquarters. This will be given effect to when the new wing is added to the existing railway headquarters building at Johannesburg.

The inspecting staff will be reorganised, the duties of one inspector will be devoted to the supervision of uniforms, personal cleanliness and appearance of the dining car staff and train attendants. An equipment inspector will be stationed at Braamfontein for the constant inspection and care of culinary utensils, cutlery, glass and crockery-ware, to ensure that all such articles are withdrawn from use when they have become unsightly or unhygienic. Recommendations have also been made in consultation with the Railway Health Officer, dealing with improved medical supervision of water supplies on trains and the supply of ice to dining cars.

Further interesting proposals are made with the object of ensuring the privacy of travellers. One such suggestion is the provision of a device which will indicate in the corridor when a passenger desires service from the dining car. Another suggestion is

the use of chimes for announcing meal-times instead of the present practice of stewards visiting compartments.

The extended use of South African dishes, fruits, preserves and konfyts is also recommended, in which connection a South African culinary expert will be consulted in regard to menus and recipes.

Proposals for alteration in the design of coaches and dining cars are also embodied in the report.

New 70 m.p.h. Union Speed Record

One of the new 4-6-2 type 16E engines, with 6 ft. 0 in. coupled wheels, recently made a test run between Hermon and Capetown, a distance of sixty miles. The run from Paarl to Belville, twenty-four miles, was covered in twenty-five and a half minutes, Belville to Woltemade, seven miles, in seven and a half minutes. Over a measured mile a speed of 70 m.p.h. was attained.

Headquarters Offices

The headquarters offices at Johannesburg are to be extended by the addition of a new wing to the present premises. This wing will completely close in the quadrangle which has had an open frontage to the town for many years. The cost of the extension will be upwards of £60,000, of which £50,000 has been provided on the current estimates. The additional accommodation will probably provide for the housing of the staffs of the Stores Department, the Catering Manager and the Airways staff.

Financial Position

The results of working for the first three months of the financial year, April to June, show a surplus of £546,890 of revenue over expenditure after allowing for special appropriations of £200,000 to betterment funds, £121,750 to pension and superannuation funds deficiency, £250,000 to rates equalisation fund, and £100,000 to writing out of capital account discount and expenses on pre-Union capital.

FRANCE

Railway Operating Economies

Financial savings effected by recent legislative measures are estimated to amount annually to 1,447 million francs, or about £19,300,000 at 75 fr. to the £. The savings include 435,000,000 fr. from reduction of the passenger tax, 300,000,000 fr. from reduction of wages, and 530,000,000 fr. from readjustment of pensions. Other substantial savings are accruing from the joint working of certain lines and services by the railway systems where co-operation is feasible.

Slow Goods Reorganisation

Reorganisation of the slow goods services is cited as an example of the progress made in bringing operating methods up to date on a commercial basis by M. Raymond Marcerou, writing in the *Journée Industrielle*. The railways have investigated the whole subject of routes for slow goods with a view to utilising the most profitable rather than the shortest routes, taking into account the distances, gradients, power of locomotives available, and the number of shuntings required. Junction stations used by two companies are jointly managed to eliminate duplication of services, and the same applies to trains and locomotives where any change-over from one company to another would involve waste.

French railways now have joint central services for such important matters as litigation, control of reception of material and equipment, and for purchases of rolling stock and supplies. Amalgamation of these services has led to further progress in the standardisation of material. Standardisation is undertaken by the O.C.E.M. Unification of rolling stock is well advanced, and now steady progress is being made in other directions. Signalling reforms, which are estimated to cost 140,000,000 fr., are likely to be completed at the end of 1936.

Signalling Reforms

Special efforts have been made to standardise apparatus used in the automatic block system with colour-light signalling. Preliminary work included unification of regulations applicable to such equipment. The railways have also undertaken the standardisation of hydraulic cranes, turntables, and pivoted barriers at level crossings.

Pivoted barriers, easily and quickly manipulated, are used in greater numbers. There were 3,383 at the beginning of 1930, 4,533 early in 1934, and 7,228 at the end of 1934. These barriers are rendered more readily visible from the road by being painted in broad red and white spiral bands and at night by the use of a reflector, known as a *cataphote*, which reflects the light from the lamps of approaching automobiles. There were 631 level crossings fitted with *cataphotes* at the beginning of 1930, 3,288 early in 1934, and 4,776 at the end of 1934.

Warnings at Level Crossings

The task of level crossing keepers has been rendered easier by means of telephones connected with the nearest station or signal cabin or by automatic warning given by an audible signal actuated by the train passing over a pedal or operating a track circuit. Early in 1930, such telephones numbered 981, while early in 1934 there were 1,273 and 1,432 at the end of 1934. The corresponding figures for automatic warning signals are 3,743, 6,542, and 7,070.

The railways have taken joint action to aid the Government in its policy of reducing the country's surplus wheat stocks by exporting as much as possible. They have reduced freight charges on all such wheat by 25 per cent. French wheat is thus finding its way to Switzerland, Germany, Great Britain, Italy and Scandinavian countries. The decision has recently been taken to extend the period of this 25 per cent. reduction until the end of 1935. Similar measures have been adopted to aid the export of fruit, the charges for fast goods service being reduced by 30 per cent.

BRAZIL

Rêde de Viação Cearense (Ceará Railway)

The Governor of the State of Ceará has forwarded complaints from producers and manufacturers in the State to the Federal Government concerning the serious difficulties encountered in the transport of merchandise owing to shortage of locomotives and wagons. Stations and warehouses are full to overflowing with consignments awaiting despatch, and unless urgent steps are taken the situation will be aggravated with the advent of the heavy crops towards the end of the year.

An idea of what this railway system could earn if it were properly equipped may be gathered from the following figures indicating net takings for the years 1932 to 1934 inclusive:—

1932 ..	.. ..	529 contos
1933 ..	.. ..	664 ,,
1934 ..	.. ..	1,420 ,,

Moreover, the improvement has been maintained this year, the increase in gross receipts for the first 5 months compared with the corresponding period of 1934 amounting to 1,105 contos.

E.F. Maricá (Maricá Railway)

The Minister of Transport has requested the Accounts Tribunal to have placed at the disposal of the above railway the sums of (*a*) 2,000 contos to be devoted to improvements and (*b*) 400 contos for the acquisition of locomotive and rolling-stock accessories and material for constructing a railcar. It is a metre-gauge system 131 km. long, running from Neves, near Nictheroy, to Iguaba Grande, near Cabo Frio, at one time partly leased and partly worked under State of Rio concession, and now wholly administered by the Federal Government.

Sorocabana Railway

Up to December 31, 1934, 240,000 contos had been spent on the new Mayrink-Santos line, earthwork and tunnelling needing 110,000 and 66,000 respectively, while bridge work, drainage and track laying consumed 36,000, and the building of various approach roads to bring up materials a further 10,000 contos. This line, which will in all probability be opened next year, will facilitate through traffic from stations on the Mogyana and Noroéste Railways (both narrow-gauge systems) to Santos, and *vice versa*, by eliminating change of train and transhipment. About 110 km. of track (50 per cent. of which is stone ballasted) are already laid, which leaves only another 30 km. to be done, this latter stretch embodying the steepest part of the *serra* and containing most of the tunnels and viaducts.

XUM

THE HORSE-POWER OF LOCOMOTIVES—ITS CALCULATION AND MEASUREMENT—VI

By E. L. DIAMOND, M.Sc. (Eng.), A.M.Inst.C.E., A.M.I.Mech.E.

This is the sixth of a series of articles giving a critical account of the work that has been done in various parts of the world on a subject that today has acquired a new importance in view of the competition between the steam locomotive and other methods of railway traction. The previous articles appeared in our issues of April 12, May 3, June 14, July 26 and September 6.

THE CONTINENTAL METHODS OF TESTING

Russian Method (Lomonossoff).—The genesis of the Russian method of testing and its importance as the first to be based on constant operating conditions have already been described.* As finally perfected by Professor G. V. Lomonossoff, it was carried out as a matter of routine by a fully organised Experimental Bureau under Government supervision. Test reports on a variety of locomotives were published, some in English,† and the whole method is fully explained and described, together with a number of detailed test reports, in Lomonossoff's classic work, "Lokomotivversuche in Russland."‡

It has already been made clear that the necessity for constant conditions in locomotive testing arises out of the fact that a locomotive has no definite normal or maximum power, and that characteristic curves of power output must therefore be related to definite conditions of working, such as a certain rate of evaporation. In a normal run at fluctuating speed over an irregularly graded road it is almost impossible to determine the instantaneous rate of evaporation or steam consumption.

Professor Lomonossoff laid it down as the main end of a locomotive test, to determine the relationship

$$F = \phi (z, V)$$

where F is the tractive force at the rim of the driving wheels, z is the rate of evaporation, V is the speed, and ϕ is the function characteristic of the locomotive. This necessitates a series of tests at several constant speeds, and several constant rates of evaporation. This desideratum he succeeded in attaining by selecting suitable lengths of long continuous gradients and hauling trains of graduated weights. Several suitable lengths of continuous grade are available in Russia, though with frequent short stretches at less than the ruling gradient. These he compensated by brake applications in the dynamometer car. By this method the fluctuations of speed can be kept so small as to maintain a sufficiently constant rate of evaporation and engine working.

It is impossible, however, to compensate by means of the brake small accelerations due to slight changes of gradient, curvature, &c., sufficiently exactly to enable such accelerative forces to be disregarded in calculating the power at the rim of the driving wheels, and in 1911 Lomonossoff proposed a method, generally known as the Russian method of testing, by which such accelerative forces may be allowed for. It involves the separate measurement of the specific rolling resistance of both locomotive and train. The equation of motion of a train (p. 1155, *R.G.*, June 14) may be written separately for the locomotive and carriages by introducing the drawbar pull, as follows:—

For the locomotive

$$\left(\frac{P}{g} + \Sigma \frac{I_1}{R_1^2}\right) \frac{dv}{dt} = F_k - F_n - (w_p + i)\, P$$

For the train

$$\left(\frac{Q}{g} + \Sigma \frac{I_2}{R_2^2}\right) \frac{dv}{dt} = F_n - (w_q + i)\, Q$$

where P and Q are as before the weights of locomotive and train respectively and w_p and w_q their respective resistances, i is the gradient, dv/dt the acceleration, and F_k and F_n are the tractive forces at the rim of the driving wheels and at the drawbar respectively. In the case of steam locomotives it is possible by a suitable combination of empty and loaded cars to make $\Sigma I_1/R^2_1 = \Sigma I_2/R^2_2$ with sufficient accuracy for experimental purposes.* In this case, dividing the first equation by P and the second by Q, we have,

$$\frac{F_k}{P} - \frac{F_n}{P} - (w_p + i) = \frac{F_n}{Q} - (w_q + i)$$

or

$$F_k = \frac{P + Q}{Q} F_n + (w_p - w_q)\, P$$

Thus the force, and hence the power, at the rim of the driving wheels can be calculated accurately without measuring gradient or acceleration.

This method has proved extremely satisfactory. It is relatively inexpensive, since no second locomotive is required, and commercial loads can be hauled, but it depends entirely on there being available suitable lengths of track with a traffic density sufficiently low to make it possible to ensure absence of signal checks during testing periods. The continuous grade must be sufficiently long to provide a test duration of not less than 35-40 minutes at the quickest speed, since this is the least time in which the steam consumption can be accurately determined. (Even this, however, does not suffice to measure accurately the coal consumption, which must be spread over several individual test runs aggregating not less than 3 hours' duration.)

It may seem a considerable complication to have to measure the specific resistance of locomotive and train separately at various speeds, but it can be done quickly, and, in the case of the train, in normal service by means of a dynamometer car. The resistance of the locomotive is determined by the method of rolling it down a gradient with the connecting rods uncoupled. The resistance at any speed is then given by the difference between the gravitational force and the product of the weight of the locomotive and the actual rate of acceleration at that speed (preferably measured by means of electrical contacts along the track). Fig. 14 shows typical curves of resistance obtained by Professor Lomonossoff for a 0-10-0 goods locomotive and train.

Varying rates of evaporation are secured by carrying out tests with various combinations of cut-off and regulator opening. Tests with full regulator opening are of the greatest importance, and should be made at cut-offs of 10,

* See p. 139, *R.G.*, July 26.

† "Tests of Different Types of Locomotives," Petrograd, 1916.

‡ Translated into German, 1926, V.D.I.-Verlag, Berlin.

* But not for turbine or diesel locomotives with their much greater rotating masses.

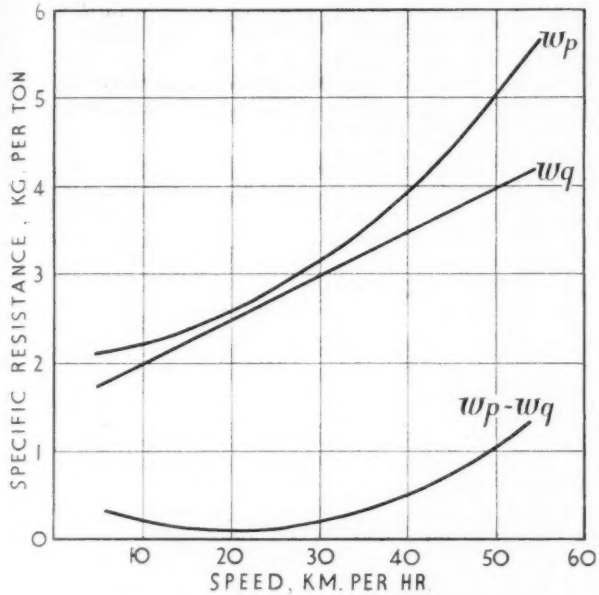


Fig. 14—Typical resistance curves (Lomonossoff)

20, 30, 40, and 50 per cent.; tests with partially opened regulator may be regarded as supplementary. As regards speed, Professor Lomonossoff's experience showed that four speeds were generally sufficient (15, 30, 45, and 62 m.p.h. for passenger locomotives* and 6, 12, 18, and 30 m.p.h. for goods locomotives). Under modern conditions in other countries two other speeds would have to be added, say 70 and 85 m.p.h., for express passenger locomotives, and 45 and 55 m.p.h. for goods locomotives. In order to obtain such a range of speed and evaporation rate, it is insufficient to vary the loading of the train; at least two suitable stretches of grade must be found, one of much less severe grading than the other.

* Runs at 75 m.p.h. were, however, made with several locomotives.

The first step in preparing from the test results the characteristic performance curves of tractive effort at the rims of the driving wheels in terms of rate of evaporation and speed [$F = \phi(z, V)$] is to construct curves of steam consumption on a basis of speed for the various cut-offs, with full regulator opening (Fig. 15). A particular rate of evaporation is then selected and the corresponding steam consumption curve drawn (shown as a dotted line, Fig. 15). To determine this curve correctly it is necessary to know what proportion of the total steam evaporated is used in auxiliary services. This must be measured during the tests. The dotted curve will cut each steam consumption curve at the speed at which the selected rate of evaporation is attained at the corresponding cut-off.

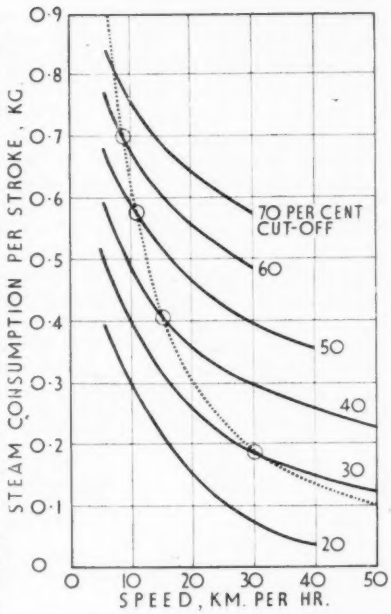


Fig. 15—Steam consumption curves (Lomonossoff)

The curves of tractive effort at the rims of the driving wheels on a basis of speed are then constructed for each cut-off and at full regulator opening (Fig. 16). On these curves are now marked points corresponding to the speeds at which the selected rate of evaporation is attained as determined by means of Fig. 15. These curves are joined by means of a new curve which constitutes the characteristic tractive force curve for the locomotive *at that rate of evaporation*. The process is repeated for various rates

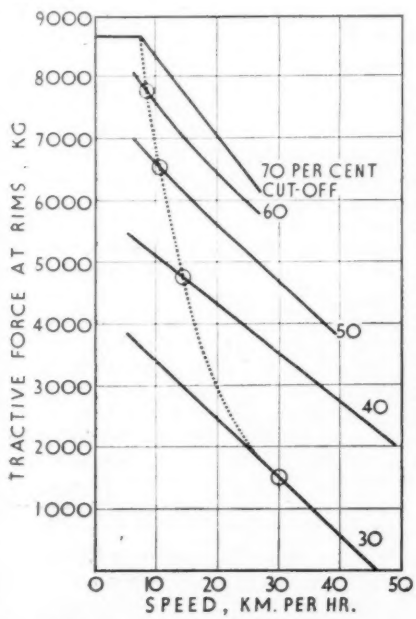
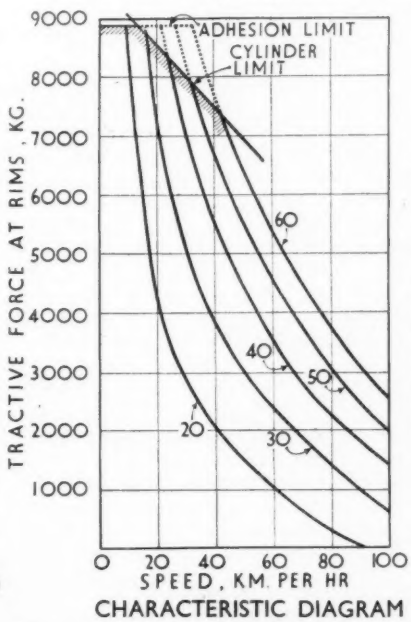


Fig. 16—Tractive effort curves (Lomonossoff)



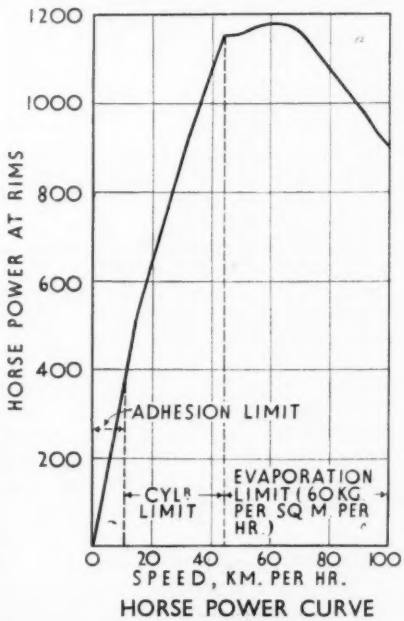


Fig. 17—Characteristic Performance curves (Lomonossoff)

of evaporation, and so the completed characteristic performance diagram is obtained. Fig. 17 shows such a diagram for a 4-6-0 locomotive tested by Professor Lomonossoff. The horizontal position of the upper limiting curve is, of course, the adhesion limit; the sloping portion is part of the tractive effort curve at maximum cut-off, since it is self-evident that the locomotive cannot attain a greater tractive force at a given speed than it exerts at the maximum cut-off which the valve gear permits and with full regulator opening. This portion of the limiting tractive effort curve varies considerably in prominence for the various locomotives tested by Professor Lomonossoff, and it is an interesting factor in design. In some cases it lies entirely outside the adhesion and maximum evaporation curves; in others it is the limiting condition over a speed range from 5 to 55 km. per hr. Its incidence depends largely on the ratio between cylinder size and heating surface, but the fact that it is so important in some cases shows that Professor Goss's assumption that the rate of evaporation at maximum power is constant at all speeds outside the adhesion range, is generally inadmissible.

Polish Method (Czeczott).—Professor A. Czeczott was assistant to Professor Lomonossoff from 1910 to 1917 and was appointed Chief Engineer of the Testing Department of the Polish State Railways in 1921. He then evolved a routine method of locomotive testing which differed essentially from the Russian method. Already in 1908 Professor Lomonossoff had made experiments with the use of an auxiliary locomotive to maintain constant conditions, but had abandoned this method as a result of one or two mishaps involving damage to the dynamometer car. Also, by making independent measurements of locomotive and train resistance, he was able, as has been explained, to dispense with the necessity of attempting to secure absolutely constant testing conditions.

Professor Czeczott, however, carried out his experiments with an auxiliary locomotive and was the first to bring this method to success.* The weight of the train is fixed so that when the test locomotive is developing its required power, the auxiliary locomotive has to exert no power, neither accelerative nor retardive, to maintain constant speed. On up gradients the auxiliary locomotive assists the locomotive under test, whilst on down grades the auxiliary locomotive together with a number of wagons, is braked. The route selected for test is fairly level, various conditions of working being obtained by varying the weight of the train.

The results of Professor Czeczott's tests are published in the form of booklets† for each standard type of locomotive, somewhat similar to the Russian " Passport Books." Performance characteristics consist of curves of indicated tractive effort and steam consumption per stroke on bases of speed and cut-off, for full open and one-quarter open regulator. Professor Czeczott has described carefully methods of reducing errors due to inequality of combustion conditions at the beginning and end of each test, and claims to have obtained a high degree of accuracy in boiler tests carried out in this manner.

Czeczott's method has also been used in France in some most interesting series of tests by the P.L.M. Railway. In one series of tests‡ comparison was made between 4-8-2 locomotives with various blast pipe arrangements. In another series§ the Henschel high-pressure 4-8-2 locomotive was tested for comparison with the standard 4-8-2 locomotives of the company and with the German Henschel high-pressure locomotive. Tests were made at 60, 80, 95 and 105 km. per hr. (37, 50, 60 and 65 m.p.h.) and at five different cut-offs at each speed. Curves show that the constancy of speed attained was remarkable, despite major changes of gradient during the run.

German Method (Nordmann).—Meanwhile in the same year (1921) that Professor Czeczott initiated his experiments a decision was made at a conference of engineers of the German State Railways, at which Professor Lomonossoff was present, to adopt the Russian method of testing. It is worth noting, in view of the present position in this country, that a good deal of opposition to the proposal was manifest at this conference, arising out of the belief that it was not possible to obtain constant conditions on the road, and that in any case the accuracy attainable must be so far short of that possible in stationary plant tests as to make the attempt not worth while.

In 1925 Professor Nordmann followed Professor Czeczott and introduced the use of auxiliary locomotives,* but with the important modification that the locomotives employed for this purpose, known as *Bremslokomotiven* (brake locomotives), are specially fitted so as to be capable of braking the train by running in reverse as a compressor. The necessary modifications are quite small. When the locomotive is running in the forward direction with the valve gear in reverse, air is sucked through the exhaust ports, and compressed in the steam passages and superheater tubes. In order not to suck in ashes from the smokebox a sliding plate valve is arranged to close the blast pipe orifice and at the same time provide an alternative opening to the atmosphere through the side of the smokebox. Hot boiler water is sprayed into the incoming air, the evaporation of which affords the requisite cooling during the subsequent compression. The compression pressure can be controlled by throttle valves which allow the compressed air to escape through suitable damping arrangements into the atmosphere. The main means of controlling the braking force of the locomotive is provided, however, by alteration of the setting of the valve gear.

It is possible in this way for a brake locomotive to exert a resistance up to one-tenth of its adhesive weight. Professor Nordmann has found that a tendency to slip, together with lubrication troubles due to excessive compression temperatures, makes it impractical to exceed this figure. It is, however, unnecessary, if more than one brake locomotive be used for the tests at greatest loads, to provide any train other than the dynamometer car and brake locomotive or locomotives. In this way a very flexible and accurate means of keeping the speed constant is provided. The brake locomotive is kept in steam and can be used to accelerate the train quickly to the test speed so as to take the maximum advantage of the available length of track. For long tests at high power the water supply of the locomotive under test must be augmented, and this can be done by means of a pipe from the tender of the brake locomotive passing underneath the dynamometer car, thus rendering the test independent of the location of water troughs, and avoiding inaccuracies of measurement of water consumption due to picking up from such troughs. Steam for auxiliary purposes, such as the provision of hot water to the dynamometer car, can also be supplied by the brake locomotive, thus eliminating other sources of inaccuracy in measurement. A typical test train is illustrated in Fig. 18.

Technically this method has thus many advantages. Its only drawback is that it is relatively expensive, since

* For a brief description of the Polish method of testing, see Int. Ry. Congress, 1931, vol. 13, p. 575.

† Published in Warsaw in Polish. No translations are available.

‡ *Revue Générale des Chemins de fer*, 1931, vol. 50, p. 273.

§ *Ibid.*, 1932, vol. 51, p. 30.

* The German testing method is fully described in *Glasers Annalen*, 1931, vol. 108, p. 52.

no paying load is hauled. But the cost is less than that involved in stationary plant testing.

The stretch of track on which the German tests are carried out is that from Grunewald to Magdeburg via Potsdam and Burg. The preliminary section is used to warm up the locomotive, the actual test stretch being from Potsdam to Burg, a distance of 57 miles, practically level throughout. Experience has shown that a good driver has no difficulty in maintaining the speed very nearly constant throughout the test run by regulation of the brake locomotive, which is fitted for this purpose with a speed indicator having a specially large dial.

Fig. 18—*German test train comprising dynamometer car and brake locomotives*

In addition to measurements of efficiency, an essential feature of the German method of testing is the provision of a standard set of characteristic performance curves for each type of locomotive, such a set of curves being reproduced in Fig. 19. These curves differ from the Russian curves in that they are drawn for one standard rate of evaporation only, that is the maximum continuous rate which it is considered desirable to maintain in service, taken to be 57 kg. of steam per sq. metre of heating surface. A number of tests at constant speed are run at different powers and cut-offs, from which, by plotting curves, it is not difficult to determine the cut-off necessary to give the required evaporation rate at this speed. A special " boiler limit test " at this cut-off and speed is then run, and the process is repeated at a number of other speeds. The characteristic performance curves are constructed directly from the results of the special " boiler limit test." The points are generally slightly scattered on account of variations of wind resistance and unavoidable slight deviations from the standard evaporation rate. The " effective drawbar pull " and " effective power " are, as has been explained, the equivalent pull and power on a dead level track at constant speed, which since Sanzin's tests has been used as the basis of measurement in Germany.

For the purposes for which such characteristic curves are used, namely fixing train schedules and draughting new designs of locomotives for given duties, it is generally sufficient to choose one rate of evaporation as is done in the German method.* Tests at other rates of evaporation, at which of course the locomotive will often work, are of value from the point of view of efficiency rather than power output. This also applies to tests at reduced regulator openings, which are a feature of the Russian method as distinct from the German.

Professor Nordman has maintained that such a set of characteristic performance curves for each main locomotive type, obtained from actual tests at a standard evaporation rate, provide the only satisfactory basis of power rating for locomotives. It has been found as a result of the systematic testing that has now been carried out by the German State Railways that considerable differences in performance may occur between locomotives of similar general dimensions, especially in the upper range of speed, which no existing formula could take account of. It has even been found that very substantial differences may exist between two locomotives of identical design,† so that in the ideal it would be desirable to test at least four locomotives of each class. Such a programme has not been carried out, on account of expense, but at least one locomotive of each standard type has been tested and the characteristic performance curves so obtained are now an essential factor in the economic operation of trains. The recent systematic acceleration of German train schedules has been one direct result of this work and the proposals for future improvements can only be carried out successfully if the work of testing is continued and extended still further into the high speed range.

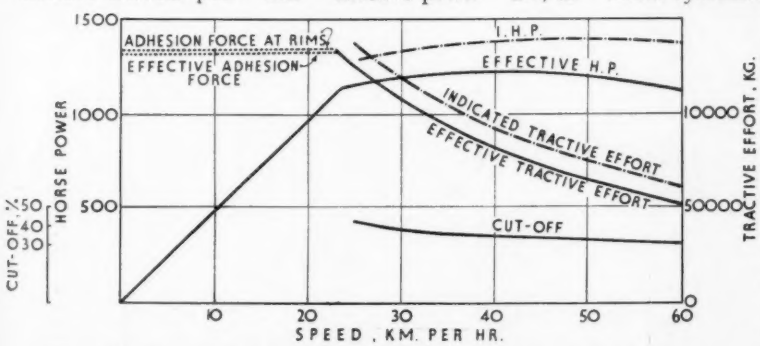


Fig. 19—*Characteristic performance curves* (*German State Railway*)
Rate of evaporation: 57 kg. per sq. metre per hour

* The most economic rate of evaporation, however, varies with the quality of the water and the cost of the fuel.

† Russian tests, however, showed very little variation between locomotives of identical design provided they were in the same condition. For instance, eleven locomotives of the 0-8-0 type were carefully examined and brought to a given standard of condition before testing. The results varied by only 4 per cent. above or below the standard. On the other hand, a 0-10-0 locomotive tested in 1915, and then retested in 1916 after a year's regular service, gave results which varied by 20 per cent.

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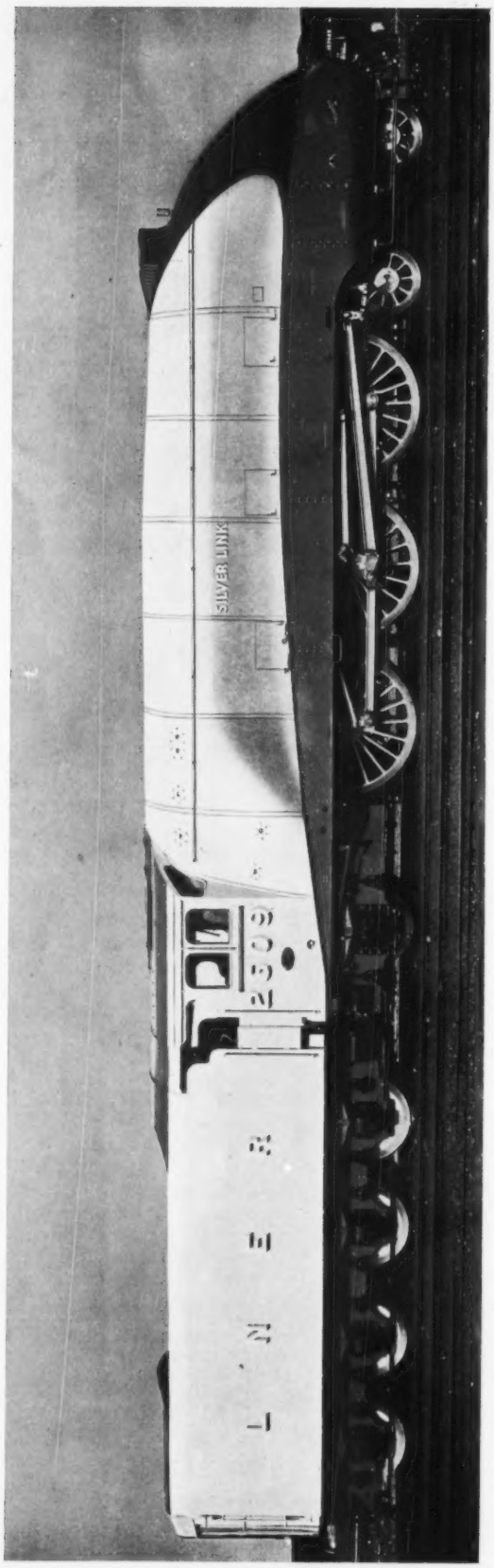
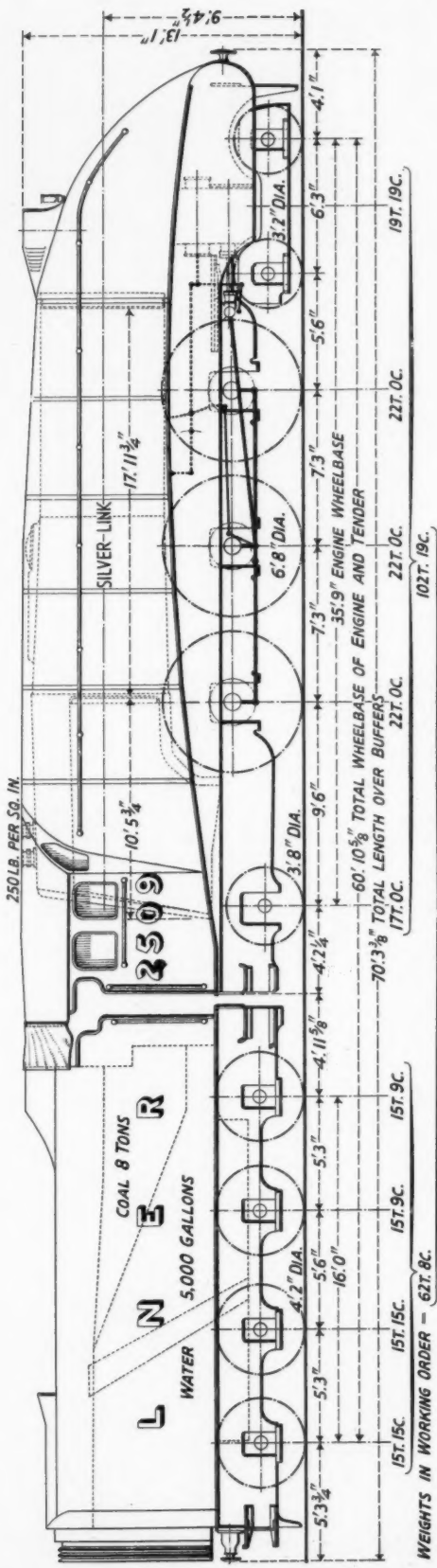
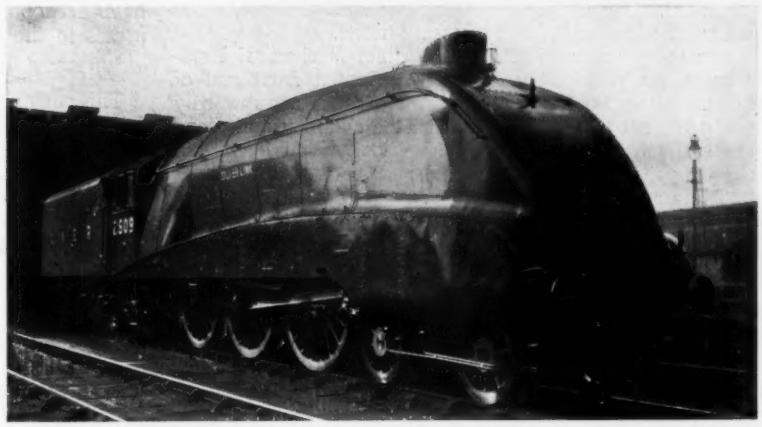




New streamlined 4-6-2 type express locomotive, London and North Eastern Railway, built at the company's works, Doncaster. Mr. H. N. Gresley, C.B.E., Chief Mechanical Engineer

NEW STREAMLINED LOCOMOTIVE AND TRAIN, L.N.E.R.

Named The Silver Jubilee, this train will be introduced on September 30, on a four-hour service between London (King's Cross) and Newcastle



AS already announced in these columns, the London & North Eastern Railway will introduce on September 30 next a four-hour service between London (King's Cross) and Newcastle, a distance of 268 miles, including an intermediate stop at Darlington. This train has been named The Silver Jubilee in celebration of H.M. The King's twenty-five years' reign. The train is a limited one, and its composition is shown on page 460. A gradient profile is reproduced on page 452 and shows also the speed restrictions in force at various points.

In view of the high speed of this train, and the fact that the head air resistance at 70 m.p.h. is approximately 50 per cent. greater than that required for 60 m.p.h., the locomotive has been streamlined.

Principles of Streamlining

An extended investigation has been made into locomotive streamlining from the three aspects of (1) reducing the head resistance, (2) lifting the steam and smoke, and (3) minimising the disturbance of the atmosphere alongside the train. A wind other than a head-on wind causes an increase in pressure on the windward side of the boiler barrel, but also induces a reduced air pressure on the lee side, and this partial vacuum draws the steam and smoke

SCHEDULE OF UP SILVER JUBILEE EXPRESS

Distance		Stations		Point to Point			
				Time	Distance		Speed
M.	Ch.			a.m.	Min.	M. Ch.	m.p.h.
		Newcastle (Central)	dep.	10.0			
5	39	Birtley	pass.	10.8	8	5 39	41·2
14	3	Durham	,,	10.18	10	8 44	51·3
23	18	Ferryhill	,,	10.28	10	9 15	55·1
36	6	Darlington	arr.	10.40	12	12 68	64·2
		,,	dep.	10.42			
41	21	Eyrholme	pass	10.48	6	5 15	51·9
50	20	Northallerton	,,	10.55	7	8 79	77·0
58	—	Thirsk	,,	11.1	6	7 60	77·5
69	2	Alne	,,	11.9	8	11 2	82·7
80	16	York	,,	11.19	10	11 14	67·1
94	2	Selby	,,	11.33	14	13 66	59·3
108	11	Shaftholme Junction	,,	11.45	12	14 9	70·6
112	30	Doncaster (Central)	,,	11.49	4	4 19	63·5
				p.m.			
129	57¾	Retford	pass	12.3	14	17 27¾	74·3
148	18¾	Newark	,,	12.19	16	18 41	69·4
162	70½	Grantham	,,	12.32	13	14 51¾	67·6
191	78	Peterborough (North)	,,	12.56	24	29 7½	72·7
209	37¼	Huntingdon (North)	,,	1.12	16	17 39¼	65·6
236	33¼	Hitchin	,,	1.33	21	26 76	77·0
250	52½	Hatfield	,,	1.44	11	14 19¼	77·7
268	27	King's Cross	arr.	2.0	16	17 54½	66·3

Overall speed, 67·07 m.p.h.

SCHEDULE OF DOWN SILVER JUBILEE EXPRESS

Distance		Stations		Point to Point			
				Time	Distance		Speed
M.	Ch.			p.m.	Min.	M. Ch.	m.p.h.
		King's Cross	dep.	5.30			
17	54½	Hatfield	pass	5.48	18	17 54½	58·9
31	73¾	Hitchin	,,	5.59	11	14 19¼	77·7
58	69¾	Huntingdon (North)	,,	6.19	20	26 76	80·8
76	29	Peterborough (North)	,,	6.35	16	17 39¼	65·6
105	36½	Grantham	,,	6.59½	24½	29 7½	71·3
120	8¼	Newark	,,	7.11½	12	14 51¾	73·2
138	49¼	Retford	,,	7.27	15½	18 41	71·7
155	77	Doncaster (Central)	,,	7.41	14	17 27¾	74·3
160	16	Shaftholme Junction	,,	7.45	4	4 19	63·5
174	25	Selby	,,	7.56½	11½	14 9	73·6
188	11	York	,,	8.9	12½	13 66	66·4
199	25	Alne	,,	8.20	11	11 14	60·9
210	27	Thirsk	,,	8.29	9	11 2	73·5
218	7	Northallerton	,,	8.35	6	7 60	77·5
227	6	Eyrholme	,,	8.42	7	8 79	77·0
232	21	Darlington	arr.	8.48	6	5 15	51·9
		,,	dep.	8.50			
245	9	Ferryhill	pass	9.3	13	12 68	59·3
254	24	Durham	,,	9.15	12	9 15	45·9
262	68	Birtley	,,	9.23	8	8 44	64·1
268	27	Newcastle (Central)	arr.	9.30	7	5 39	47·0

Overall speed 67·07 m.p.h.

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down into it and tends to obscure the look-out. If the locomotive front end is designed with a vertical wedge front to pierce the atmosphere by parting it to the sides, the side wind effect is aggravated and the tendency of the steam and smoke to drift along the boiler barrel is increased. Then, too, considerable disturbance is caused laterally, and this is felt by passing trains.

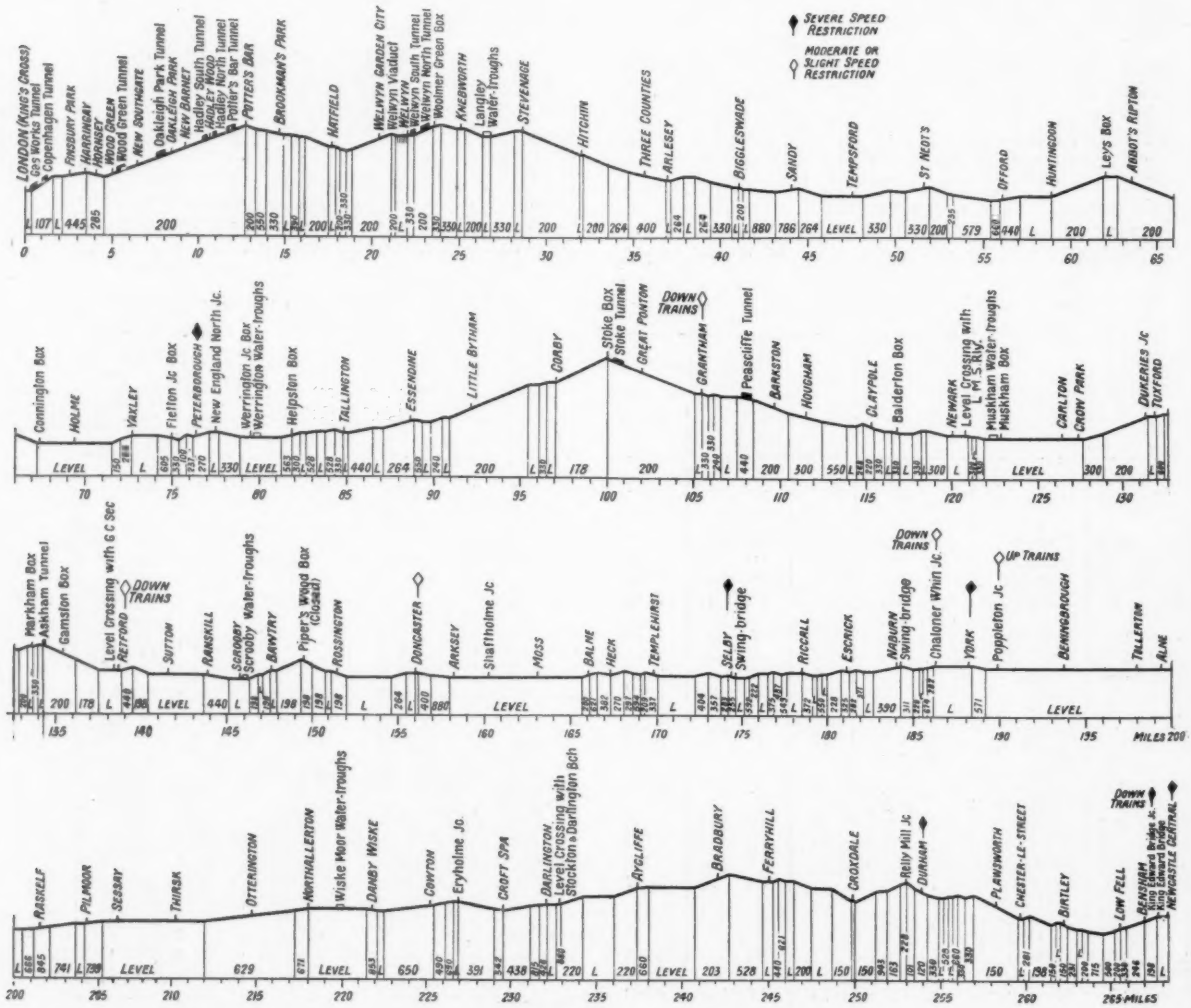
For these reasons Mr. Gresley, Chief Mechanical Engineer of the L.N.E.R., decided to adopt a front end of horizontal wedge form, as this would cause an upwardly rising current of air to sweep past the chimney and along the boiler barrel top, and by its velocity would assist in carrying the steam and smoke clear over the cab, besides avoiding any lateral displacement of the atmosphere. The running boards were given the form of an aerofoil for the same reason. The form of streamlining adopted is very similar to that incorporated in the Bugatti high-speed railcars in France and in the racing motorcars built by the same firm.

Four streamlined engines are being built at the company's Doncaster works, the first of which has been numbered 2509 and named *Silver Link*. In order to give access to the smokebox, the sloped front plate is divided into two parts, the larger hinged at the top lifting upwards and the lower hinged at the bottom lifting forward and downwards over the buffers. These doors are operated from the ground by a handle on a cross shaft in front of the smokebox, the lower door overlapping the top door when closed. Inspection doors have been provided along the sides of the engine to give access to the different parts of the motion.

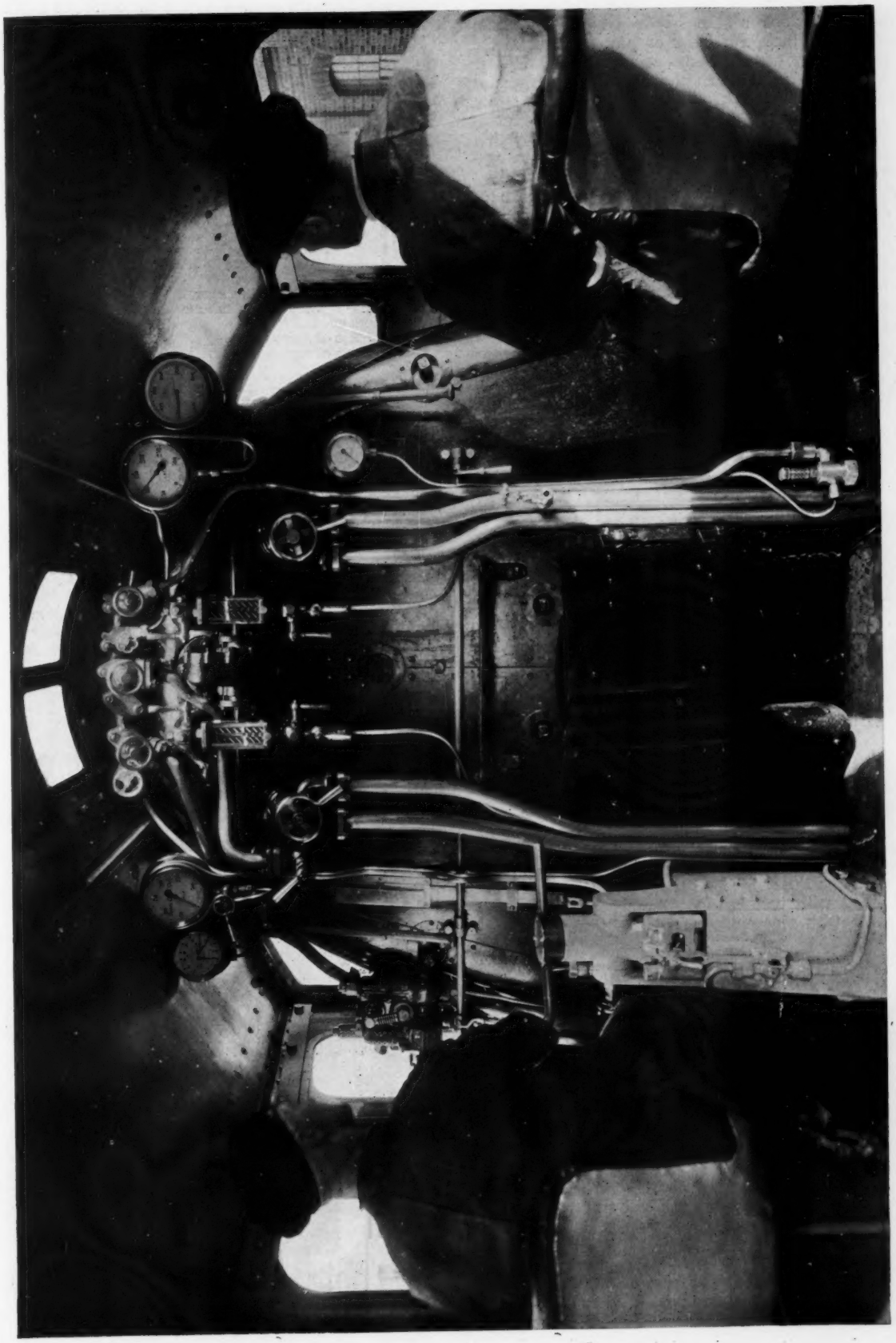
Engine Details

The engine is a development of Mr. Gresley's successful three-cylinder simple-expansion Pacific type with the boiler pressure increased to 250 lb. per sq. in. The principal dimensions are shown on the diagram and in the table on page 454.

It will be noticed that the boiler differs from those of the former Pacifics in having a combustion chamber giving a firebox 10 ft. $1\frac{3}{4}$ in. long. It is of copper, and the wrapper plates are $\frac{9}{16}$-in. and the tube plate $1\frac{1}{4}$ in. thick. The throat plates of both the copper box and of the outer casing are each in one piece. A new design of firebar is used giving air space openings equal to 56 per cent. of the grate area, part of which is arranged to drop. The ashpan is completely welded, and the design gives a free air flow under the outer side bars. As in the



Gradient profile of L.N.E.R. main line between London (King's Cross) and Newcastle



Interior of cab showing ample window spacing, controls and fittings. Note comfortable seats provided for the enginemen

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last batch of Pacifics and the two 2-8-2 express locomotives of the "Cock o' the North" type, the steam supply is taken through a series of ½-in. slots cut in the top of the boiler plate into a steam collector which is a steel pressing integral with the dome. The regulator is of the double beat type and feeds into a main steam pipe of 7 in. diameter. The superheater is of the Robinson type, with 43 short loop elements extending to within 9 in. of the copper tubeplate, and expanded into a cast steel header. The whole of the boiler barrel and firebox are insulated with mattresses comprising five layers of Alfol foil and 1½-in. mesh wire netting. The boiler is fed by two injectors; that on the right hand side of the engine is a Davies & Metcalfe No. 10 exhaust steam injector, and that on the left a Gresham & Craven live steam under-footplate injector.

Each of the three cylinders, which are 18½ in. diameter instead of 19 in. in the former Pacifics, is cast as a separate unit, the exhaust from the outside cylinders being carried to the blast pipe base through a cast steel saddle. The piston valves are of the narrow ring type with ring control, and are increased to 9 in. diameter with a steam lap of 1⅛ in. Each cylinder has its own 5 in. diameter steam pipe from the header, and special care has been taken to make the exhaust passages smooth in order to reduce the friction. The blast pipe nozzle is 5¼ in. diameter and is provided with a jumper ring, of the type introduced by the late Mr. Churchward on the G.W.R., to relieve back-pressure when working the engine at a long cut-off. The piston and rod are combined in one forging of B.S.S. Class C Steel. The connecting and coupling rods of nickel chrome steel are similar to those at present fitted to the ordinary Pacific engines. Of the total reciprocating weight, 40 per cent. is balanced at the wheel rim.

The valve gear is of the company's standard type, in which the outside valves are operated by means of Walschaerts gear, and the inside valve by the Gresley gear incorporating a system of equal and 2:1 levers. The valve gear throughout is fitted with ball and roller bearings. The maximum cut-off is 65 per cent., at which position the valve travel is 5¾ in. The coupled axleboxes are lubricated by means of a Wakefield six-feed mechanical lubricator, and Armstrong oiler pads are used in the axlebox trays. A Wakefield mechanical lubricator is also used for the lubrication of the valves and cylinders, one feed being placed in each steam pipe and one on the top of each cylinder barrel. The two lubricators are driven from one return crank on the right hand trailing crankpin, and the gear is fitted with ball bearings throughout. Four oil boxes, each with nine syphon feeds, lubricate the valve spindles, piston rods, &c.

The locomotive is fitted with vacuum brake. The three 21 in. diameter brake cylinders are arranged to transmit their load to one main shaft and give a total brake power equal to 86 per cent. of the adhesive weight. The brake shafts are of forged steel, and the brake arms and levers electrically welded. Reversing gear of the vertical screw type fitted with ball thrust washers and with a special vacuum locking apparatus is provided. Bowden wire is used for the sanding gear and cylinder cock controls, as well as for operating the whistle, the latter being of the chime type, and mounted in front of the chimney.

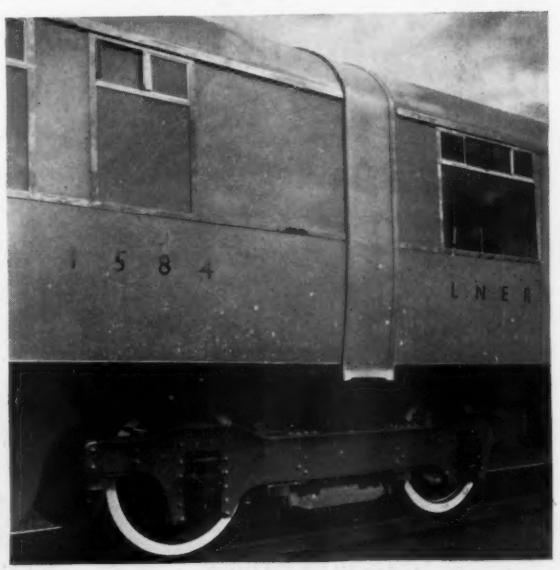
Bucket seats are provided for the driver and fireman, and to eliminate back draught flexible rubber roofing is fitted over the gap between the cab and tender. In addition to the usual cab fittings, a pyrometer and speed recorder of the Flaman type are fitted. The tender is of the corridor eight-wheeled type and is equipped with well and water scoop; it has a capacity of 5,000 gallons of water and 8 tons of coal, and is fitted with standard Pullman vestibule and buckeye couplers. The back is rounded to conform to the shape of the carriages to which it is coupled.

The principal dimensions and ratios of the locomotive are given below:—

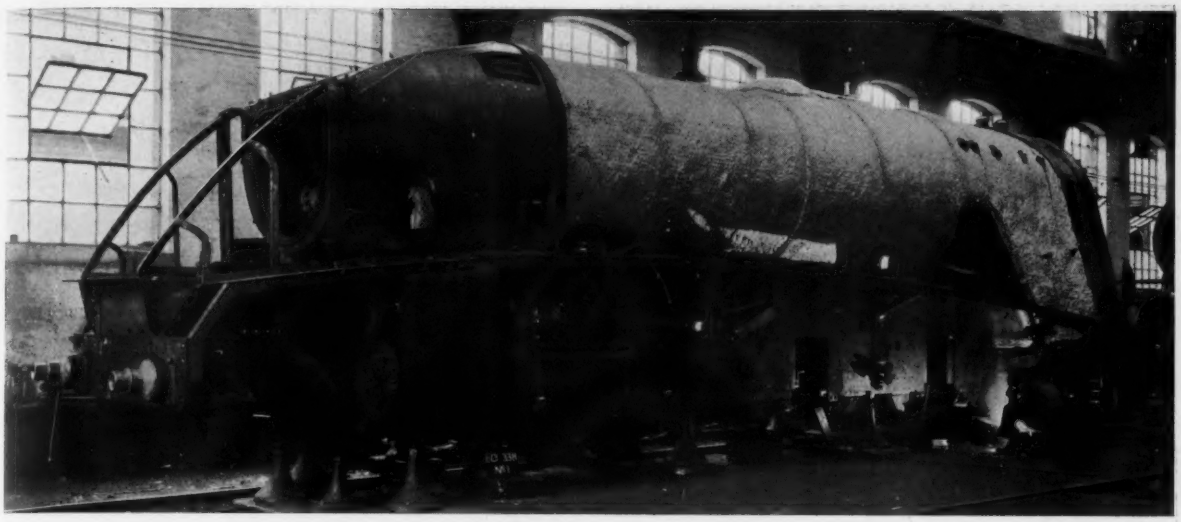
Cylinders (3)	18½ in. dia. × 26 in. stroke.
Wheels, dia.—	
Bogie	3 ft. 2 in.
Coupled	6 ft. 8 in.
Trailing	3 ft. 8 in.
Wheelbase—	
Coupled	14 ft. 6 in.
Total engine	35 ft. 9 in.
Engine and tender	60 ft. 10⅝ in.
Journals—	
Bogie	6½ in. dia. × 9 in. long.
Coupled wheels	9½ ,, ,, × 11 ,, ,,
Trailing	6 ,, ,, × 11 ,, ,,
Boiler—	
Outside length of firebox overall	10 ft. 5⅝ in.
,, ,, ,, at bottom	6 ft. 8 in.
Maximum dia. of barrel	6 ft. 5 in.
Thickness of barrel plates	13/16 in. × 7/8 in.
Thickness of wrapper plates	9/16 in.
Tubes (steel)—	
Small	121
Outside diameter	2¼ in.
Thickness	10 I.W.G.
Length between tubeplates	17 ft. 11¾ in.
Superheater flues	43
Outside diameter	5¼ in.
Thickness	5/32 in.
Heating surface—	
Firebox	231·2 sq. ft.
Tubes	1,281·4 ,, ,,
Flues	1,063·7 ,, ,,
Total (evaporative)	2,576·3 ,, ,,
Superheater elements	749·9 ,, ,,
Combined heating surface	3,325·2 ,, ,,
Grate area	41·25 ,, ,,
Tractive effort at 85 per cent., boiler pressure	35,455 lbs.
Adhesive weight	66 tons
Adhesive factor	4·18
Weight of engine and tender (working order)	165 tons 7 cwt.

The Silver Jubilee Train

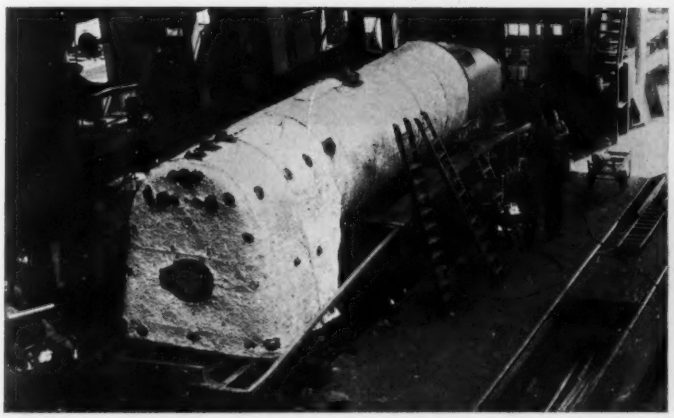
The formation of the train is shown diagrammatically, and its exterior finish is a departure from the company's usual practice. Instead of the standard varnished teak the bodies are panelled in Lysaght's No. 6 gauge steel and



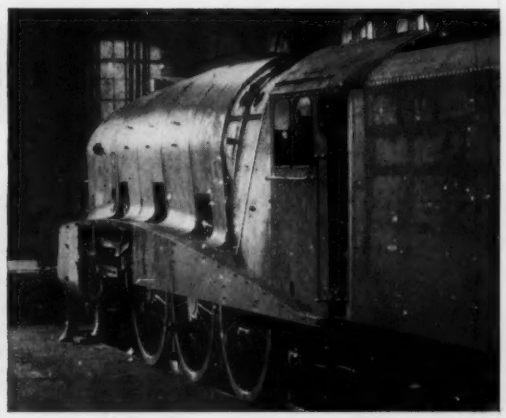
Rubber sheeting covering the space between ends of coaches to exclude ingress of air



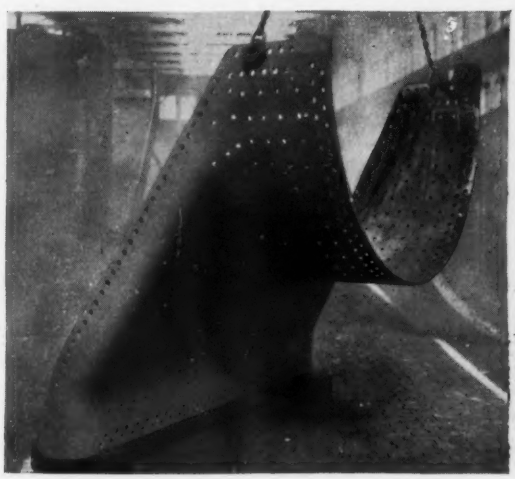
The first engine during construction in the Doncaster works



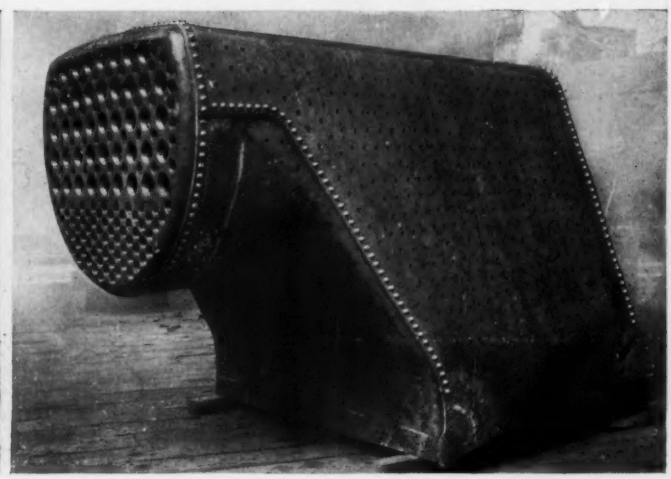
Boiler and framing of second engine



First engine wheeled and nearing completion



Steel throat plate of outer firebox



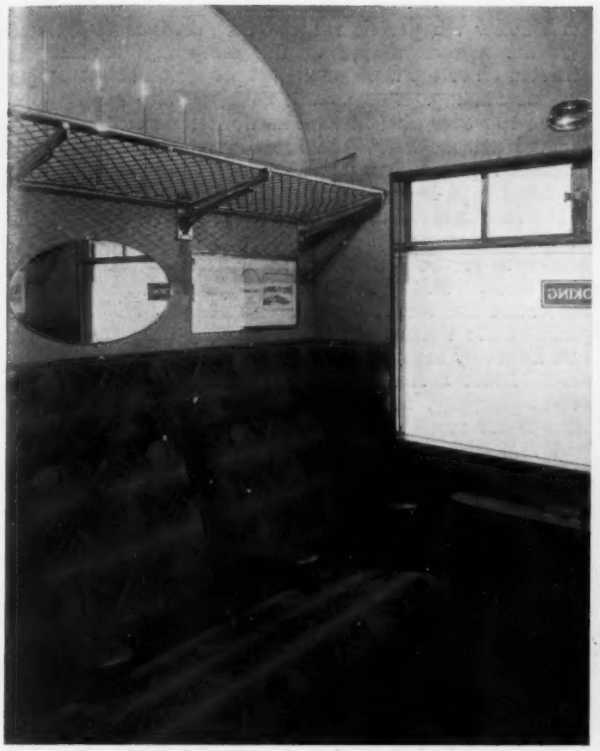
Copper interior firebox with combustion chamber

XUM

Interior of first class restaurant car

Saloon portion of semi-open first class coach

NEW STREAMLINED LOCOMOTIVE AND



Interior of third class compartment

Interior of first class compartment

View in pantry with boiler and coffee machine

View in kitchen fitted with electric cooking apparatus

TRAIN, LONDON & NORTH EASTERN RAILWAY

XUM

covered with aluminium finished Rexine; the cornices, door, window facias and bottom beading are in stainless steel.

Exterior projections have been reduced to a minimum and between the bogies there is a skirting to within 10¼ in. of the rail. The space between the articulated ends of the vehicles are closed with special aluminium-finished rubber sheeting, supplied by G. Spencer Moulton & Co. Ltd., fitted with initial tension. The steel underframes, mounted on standard L.N.E.R. compound bolster bogies, have been built up by electric welding. The body underframing is of teak, and the floors are bolted directly to the underframes without body cushions. The steel panels are bedded to the pillars with a special paste before being finally screwed into position, and the special weather resisting Rexine covering is fixed to the steel panels by chemical adhesive. The floors, roofs, and walls are insulated with an acoustic asbestos blanket supplied by J. W. Roberts Limited. Further to deaden sound, corrugated steel sheeting has been welded between the underframe members, and the space between it and the floor sprayed with asbestos insulation. The large side windows of the saloons and compartments are fitted with double glass having an air space of ¼ in. between in order to insulate heat and sound.

Plywood has been used for the interior body lining, except the ceilings, which are of special millboard. All cross partitions, except those in the restaurant cars are of block plywood.

Ventilation and Equipment

The whole of the train, with the exception of the kitchen car is equipped with the special heating and ventilating system of J. Stone & Co. Ltd. Fresh filtered air is forced into the compartments near floor level, and in cold weather the air is heated to the required temperature according to the predetermined setting of a special compensated thermostat. The equipment consists of a unit, suspended from the underframe, which contains the necessary fan, air filters and heating apparatus, from which the air is conveyed to the compartments by lagged metal ducts. It passes to the outside atmosphere by means of extractor type sliding shutter ventilators situated over each body side light, and also through perforated metal grids situated over each compartment sliding door.

The interior decoration of the various units introduces several novel features. The first class compartments, each of which seats four passengers, have been decorated in blue with chromium plated metal fittings. The walls above the seat backs are covered with blue Rexine and the ceiling with Rexine of a lighter shade. The basis of the whole design is to provide a feeling of spaciousness in the compartment, and this is enhanced by the provision of vertical chromium plated luggage strips on the partition.

The seats are upholstered in silver and blue broche rep, and seat fillings are of the Vi-Spring type. The hinged centre armrests, the side armrests, and the headrests have fillings of Dunlopillo rubber. Loose feather cushions in blue silk are also provided. Each window is provided with a blind of blue Rexine, whilst silver and blue silk curtains are fitted to each body side light.

Tubular lamps are used throughout; a 35-watt lamp in a chromium plated reflector is fitted in the centre of the ceiling. Tubular reading lamps of 15-watts capacity are fixed in each corner above the seat back. Each tubular reading lamp previously described provides illumination from one particular position, but in order to give a good general lighting just above seat level, a large rectangular mirror has been placed over each seat back below the parcels rack. This mirror is so inclined that the light from the tubular lamp in the ceiling is reflected on to the book or newspaper which the passenger may be reading. The floor is covered with a blue jaspe Wilton rug over blue lino. The third class compartments seat six persons each, and are decorated in green, with chromium plated fittings. Lighting is provided by two 30-watt lamps in chromium plated ceiling fittings.

The first class restaurant car is on modern lines, the walls in this saloon and in the open portion of the adjacent semi-open car being panelled in figured Australian maple. The whole finish is entirely flush, the necessary decorative and architectural effects being provided by the grain of the timber, the whole forming a hygienic finish free from any mouldings or projections which might collect dust. Loose chairs are provided, one on each side of a centre gangway, and are upholstered in a blue tapestry with trellis design; the seat fillings are of the Vi-Spring and Vito type. The ceiling is tinted pale blue. The floor is covered with a sponge rubber underlay, on which is placed a blue jaspe Wilton carpet. Tubular lighting is again employed in this saloon; two 35-watt tubular opal lamps in chromium reflector type fittings are fixed to the cornice above each side window. A fixed standard table lamp with a beige Nacrolaque shade is fixed to the waist rail at each table.

The walls of the third class restaurant car are flush-panelled in quartered teak, and the fittings throughout are chromium plated. The fixed seats are arranged two on one side of the gangway and one on the other, and are upholstered in green uncut moquette. The carpet in the third class restaurant car is fawn with a black and green pattern; a sponge rubber underlay is provided. Each section is lighted by means of one 60-watt opal lamp in the centre of the ceiling.

Triplet Restaurant Car Set

The kitchen, which comprises the centre unit of the triplet restaurant car set, has a large kitchen, pantry, attendants' compartment and attendants' toilet, and is provided with electric cooking apparatus. The power equipment follows generally the lines of the previous equipments supplied by J. Stone & Co. Ltd., but considerable changes have been made in the actual cooking appliances, the finish of which is generally in stainless steel and vitreous enamel. A great saving in weight has been obtained by using light steel sections electrically welded for the stoves and accessories instead of the usual cast iron. A special feature of the boiling table is that the whole of the top surface is heated and is not, as hitherto, composed of small separate heating elements. A hot cupboard has been provided on the corridor side, the top of which has been constructed to form a heated carving table with special wells for sauces, gravies, &c.

A novel feature is the provision of sinks each having a 1 kW heating element clamped to the under side, to ensure that the water remains hot during the process of washing up. The tops of the benches are covered in stainless steel plates. An automatic electric refrigerator is also provided in the kitchen, together with an ice cream cabinet operated from the same unit. There is an extension of the refrigerator in the pantry for the accommodation of wines, butter, cheese, &c., and an automatic hot water boiler supplies hot water to the kitchen and pantry. The walls and ceiling of each toilet compartment are covered with Rexine, whilst the floor is covered with Korkoid, suitably tinted to match the walls. All metal fittings are chromium plated. Hot and cold water is provided in all wash basins.

(*Illustrations of the train and list of contractors appear on pages* **460** *and* **461**.)

RAILWAY NEWS SECTION

PERSONAL

We regret to record the recent death of Sir Thomas Henry Grattan Esmonde, Bt., sometime Chairman of the former Dublin & South Eastern Railway. Sir Thomas, who was 72 years of age, was elected to the board of the D. & S.E.R. in 1901, and was Chairman from 1921 until the end of 1924, when he resigned on the amalgamation of his company with the Great Southern Railways. He was M.P. successively for Co. Dublin, South; West Kerry and North Wexford from 1885 to 1919, and became a Senator of the Free State in 1922: he has been a Member of the Dail for Co. Wexford since 1923.

The following appointments have been made by the Secretary of State for the Colonies:—

Mr. R. E. Robins, O.B.E., Assistant Superintendent of the Line, Kenya & Uganda Railways and Harbours, to be General Manager, Tanganyika Government Railways.

Commander G. A. C. Sharp, D.S.C., R.N. (Retired), Marine Officer, Tanganyika Government Railways, to be Marine Superintendent, Takoradi, Gold Coast Government Railway and Takoradi Harbour.

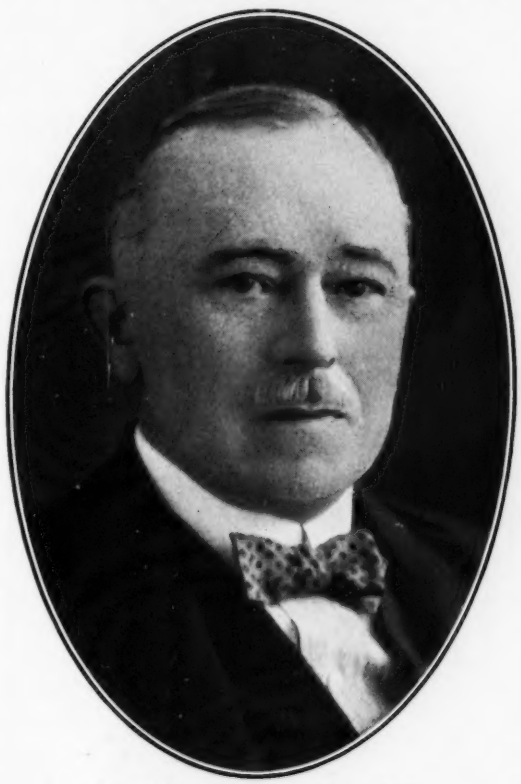
Mr. D. Philip to be Expenditure Accountant, Federated Malay States Railways.

Major E. J. Soper to be Assistant Revenue Accountant, F.M.S.R.

Mr. A. H. Joscelyne, who, as announced in THE RAILWAY GAZETTE of August 16, was permitted to retire from Indian Government service on July 6, had been carrying out the duties of Locomotive Superintendent and Chief Mechanical Engineer of the Eastern Bengal Railway since 1926. Born in 1880, he was appointed an Assistant Locomotive Superintendent, State Railways, in 1901. Five years later he attained district rank, and was appointed Deputy Locomotive Superintendent in 1917. In May, 1926, he was appointed to officiate as Locomotive Superintendent, and this appointment was confirmed in January, 1929, the designation having latterly been changed to Chief Mechanical Engineer. Mr. Joscelyne was on military duty with the Indian Expeditionary Force "B" during the war, and was also awarded the V.D.

Mr. J. R. Harrison, F.G.S., has been confirmed as Chief Mining Engineer, Indian Railway Board, as from June 14.

Mr. Andrew Custance Carr, V.D., M.I.Mech.E., President of the Institution of Locomotive Engineers, 1935-1936, received his early training on the former North Eastern Railway at the Gateshead locomotive works, and subsequently was employed for three years in the inspection of materials and boilers and of outside machinery. In 1892 he entered the service of the East Indian Railway as an assistant in the Locomotive Department, and his association with that company lasted fourteen years, during which time he occupied successively the positions of District Locomotive Superintendent, Works Manager, and Deputy Locomotive Superintendent. He transferred his service to the Bengal-Nagpur Railway in 1905, becoming Deputy Chief Mechanical Engineer and Works Superintendent at Khargpur, where new locomotive, carriage and wagon workshops were under construction. In 1909 he visited the principal railway workshops in Canada and the United States of America, and in 1912 was appointed Chief Mechanical Engineer of the Bengal-Nagpur Railway. He was Chairman of the Locomotive, Carriage and Wagon Superintendents' Committee of the Indian Railway Conference Association during its 1917-18 session. Subsequently, his services were lent to Great Britain, and in 1918-19 he was General Manager of the Coventry Ordnance Works. After the cessation of hostilities he returned to India, and in 1920 was appointed to act as Agent of the Bengal-Nagpur Railway, serving on the Bengal Chamber of Commerce and as a Commissioner of the Port of Calcutta in 1920-21. On returning to England, Mr. Carr was admitted a Partner in the firm of Sir John Wolfe Barry & Partners, Consulting Engineers. In 1932 he was commissioned to report on the locomotive department of H.E.H. the Nizam's State Railway. Mr. Carr holds the rank of Major in the Bengal-Nagpur Railway Regiment of the Auxiliary Forces.



Mr. Andrew Custance Carr, V.D.,
President, Institution of Locomotive Engineers, 1935–36

We regret to note the death, on September 17, of Mr. James Stones, Unionist M.P. for the Farnworth Division of Lancashire and sometime Cashier at Horwich works, Lancashire & Yorkshire Railway. Mr. Stones, who was 67 years of age, joined the Traffic Department of the L. & Y.R. in the Bolton area, and eventually rose to be Cashier at Horwich, where he was responsible for the payment of the 4,000 men employed in the works there: he retired from the railway in 1928. He was also Chairman of the Farnworth Urban District Council and a magistrate for Lancashire. He took a leading part in local social movements, and was elected National Conservative Member for the Farnworth constituency at the last general election.

Mr. G. Feather, late Joint Managing Director, William Asquith Limited, Halifax, has joined James Archdale & Co. Ltd., Birmingham, and will take up his duties as Chief Engineer at the Worcester works of that firm during October.

INDIAN RAILWAY STAFF CHANGES

Mr. J. H. Carpenter, Publicity Officer, G.I.P.R., has been granted 10 months' leave as from July 9.

Mr. G. J. B. Bevan, M.B.E., Deputy Agent, Burma Railways, has been granted two years' leave preparatory to retirement, as from April 9.

Khan Bahadur G. Z. Khan has been appointed to officiate as Deputy Chief Accounts Officer, N.W.R., as from August 3.

XUM

General view of locomotive and train, with diagrammatic drawings, in elevation and plan, of the arrangement of the coaches

(*See article on pages* 451–458 *and list of contractors opposite*)

Visit of Southern Railway Officers to the United States and Canada

A number of Southern Railway Officers are sailing in the Cunard White Star Liner *Berengaria* from Southampton on October 2 next for a month's visit to the United States and Canada.

The objects of the tour are various, and include investigation into the following: High speed streamline trains (diesel or steam-operated), such as the Burlington Zephyr, Hiawatha, and Abraham Lincoln; air-conditioning of dining and other cars; handling of rush hour traffic to and from the big cities; cleaning of rolling stock; containers; road and rail co-operation; air-rail co-operation; control of road rates; port and dock equipment, &c.

The party will consist of:—

Traffic Department

Mr. J. B. Elliot, Assistant Traffic Manager
Mr. W. J. England, Asst. Supt. of Operation
Mr. J. E. Sharpe, London (West) Div. Supt.

Docks & Marine Department

Mr. E. J. Missenden, Docks and Marine Manager
Mr. C. T. Pelly, Outdoor Assistant

Chief Mechanical Engineer's Department

Mr. W. Marsh, General Asst. to Chief Mechanical Engineer

In addition, Mr. Elliott, who is the Southern Railway's representative on the Co-ordinating Committee of Associated British Railways, Inc., the joint organisation in America, will make contact with the leading American and Canadian tourist agents and travel organisations, and in this connection he will travel across to the Pacific Coast if time permits.

Mr. T. R. Dester, General Traffic Manager, Associated British Railways, Inc., New York, who is now in England, will also return with the party, and Mr. C. M. Turner (London Midland & Scottish Railway), the Secretary of the Co-ordinating Committee in London, will also sail in the *Berengaria* for a short visit in connection with the working of the office. The party will return from New York on November 8 in the Cunard White Star Liner *Aquitania*.

New Streamlined Locomotive and Train, L.N.E.R.

(*See illustrated article on pages* 450-458 *and opposite*)

The following is a list of firms who supplied material and fittings used in the construction of the locomotives and train:—

LOCOMOTIVES

Firm	*Material*
Colvilles Limited	Main frame plates
Colvilles Limited and Parkgate Iron & Steel Company	Steel boiler plates
I.C.I. (Metals) Limited	Copper firebox plates.
North British Steel Foundry & Coltness Iron Co. Ltd.	Wheel castings
Howell & Co. Ltd.	Boiler tubes
The Superheater Co. Ltd.	Superheater elements
Thomas Firth & John Brown Limited	Nickel chrome steel connecting rods
Monkbridge Iron & Steel Co. Ltd.	Combined piston and rod forgings, steel tyres and axles
Ibbotson Bros. & Co. Ltd.	Laminated springs
George Spencer Moulton & Co. Ltd.	India rubber auxiliary springs, India rubber for buffer and drawgear
Ransome & Marles Bearing Co. Ltd.	Roller bearing for Walschaert valve motion
Skefko Ball Bearing Co. Ltd.	Spherical ball bearing
Hoffmann Manufacturing Co. Ltd.	Roller and ball bearings for two to one lever
Ateliers Vaucanson	Flaman speed recorder
C. C. Wakefield & Co. Ltd.	Mechanical lubricators
Davies & Metcalfe Limited	Ejector and exhaust steam injector
Gresham & Craven Limited	Live steam injector
R. L. Ross & Co. Ltd.	Safety valves
Alfol Insulation Limited	Boiler clothing
English Steel Corporation Limited	Built-up crank webs
Thomas Firth & John Brown Limited	Built-up crankshafts
Dorman Long & Co. Ltd., and The Steel Company of Scotland	General steel plates
Robert Hyde & Son Ltd., Hadfields' Limited, W. Jessop & Sons Ltd., Coltness Iron Co. Ltd.	General steel castings
Taylor Bros. & Co. Ltd.	Disc wheels and axles for tender

COACHES

Firm	*Material*
John Lysaght Limited	Exterior steel panels
Wm. Mallinson & Sons Ltd.	Maple and teak veneer, interior panels
I.C.I. (Rexine) Limited	Exterior and interior Rexine

Coaches (*cont.*)

Firm	*Material*
J. Stone & Co. Ltd.	Electric lighting dynamos and equipment, electric cooking dynamos and equipment, pressure ventilation equipment
Henry Wilson & Co. Ltd.	Electric cooking, kitchen equipment, ovens, &c.
W. M. Still & Sons Ltd.	Buffet counter equipment; electric light fittings, 3rd class
Maple & Co. Ltd.	Electric light fittings, 1st class
Pritchett & Gold and E.P.S. Co. Ltd.	Cells for electric lighting equipment
Chloride Electrical Storage Co. Ltd.	Cells for electric cooking equipment
Firth-Vickers Stainless Steels Limited	Stainless steel mouldings, light frames, letters, and figures
James Beresford & Son Ltd.	Louvre ventilators and interior fittings
Joseph Kaye & Sons Ltd.	Locks, latches, &c.
Vi-Spring Products Limited	Seat springs, &c.
Dunlop Rubber Co. Ltd.	Dunlopillo head and arm rests

Coaches (*cont.*)

Firm	*Material*
Arthur H. Lee & Sons Ltd.	Tapestry
John Holdsworth & Co. Ltd.	Moquette
T. F. Firth & Sons Ltd.	Broche, rep, carpets, and rugs
Korkoid Decorative Floors	Korkoid floor covering
Light Alloys Limited	Alpax door droplight frames
British Automatic Refrigerators Limited	Refrigerating apparatus and ice cream cabinet
Beckett, Laycock & Watkinson Limited	Dovetail steel sheeting for floors
J. W. Roberts Limited	Sound insulation for floors, main steam pipe insulation
George Spencer, Moulton & Co. Ltd.	India-rubber for streamlining, vestibule diaphragms, I.R. springs, &c.
Docker Bros.	Special aluminium paint and paint for interior decoration
Passenger Communication Co. Ltd.	Passenger communication fittings
Pilkington Bros. Ltd.	Glass
Twyfords Limited	Lavatory equipment
Doulton & Co. Ltd.	Washbowls
A. G. Wild & Co. Ltd., Laycock Engineering Company, and G. D. Peters & Co. Ltd.	Interior fittings

RAILWAY SERVANTS' ORPHANAGE.—The report for the year to April 30, 1935, of the Railway Servants' Orphanage, Derby, recalls the fact that this is the diamond jubilee of the orphanage, which was established in January, 1875. It provides for the fatherless children of railwaymen of all grades. Since 1875, over 2,350 children have been admitted and given a comfortable home whilst being carefully trained to afford them every possible chance of success in life. The committee again reports an increase in the total income of the orphanage at £16,398, as compared with £15,750 in the previous year, despite a fall of nearly £580 under the head of legacies. The total outlay for the year (including outfits and scholarship expenses) was £14,757, an increase of £3,365 on that of the previous year; of this increase, however, extraordinary expenditure accounted for £3,346. The new heating installation has, after nine months' working, effected a considerable saving in running costs, and ensures an even temperature throughout the building on the coldest of days. The average number of children maintained was 226, and the average cost per child £44 4s.

STEPHENSON LOCOMOTIVE SOCIETY.—The titles of certain lectures in the winter programme of the Stephenson Locomotive Society promise novelty of approach combined with interest of subject-matter. Among the speakers will be Mr. J. N. Maskelyne, A.I.Loco.E. (the President), on "Locomotive Types which have Not Fulfilled Expectations" (October 11), and Mr. A. G. Williamson, (Member of Council) on "Ornament, Decoration, and the Æsthetic in the Design of Locomotives" (November 11). In the New Year it is hoped to arrange lectures from Mr. W. A. Willox, A.C.G.I., A.M.Inst.C.E., on "Permanent Way," and from Mr. B. Adkinson, B.Sc., on "Locomotive Operation." A photographic competition and exhibition of members' work will be held later.

XUM

The Winter Train Services

London & North Eastern Railway

The most important addition to the L.N.E.R. service is, of course, the Silver Jubilee express, which will leave Newcastle at 10 a.m., and Darlington at 10.42 a.m. (with a special connection from West Hartlepool at 9.35 a.m., Stockton at 10 a.m. and Middlesbrough at 10 a.m.), reaching King's Cross at 2 p.m.; on the return journey the departure from King's Cross will be at 5.30 p.m. reaching Darlington at 8.48 p.m. and Newcastle at 9.30 p.m. The time of 198 min. scheduled for the 232·3 miles between London and Darlington (including the severe slacks through Peterborough, Selby, and York) gives a start-to-stop average of 70·4 m.p.h., which is easily the fastest in the world for any non-stop run exceeding 200 miles in length.

The existing 5.30 p.m. down Newcastle express will be amalgamated with the 5.45 p.m. from King's Cross to Hull, at the latter hour, but notwithstanding the additional Doncaster stop, the Newcastle section will reach the Tyneside city at 10.55 p.m., so taking only 3 min. longer on the journey than at present. The 105·5 miles from London to Grantham will be run in 113 min., and the 50·5 miles thence to Doncaster in 50 min. (public time 51 min.), and the time of 4 hr. from London to Hull will be 3 min. less than previously. In the reverse direction the 8.15 a.m. from Newcastle to London will stop at Doncaster to attach the Hull portion (the independent express due in London at 1.15 p.m. being withdrawn), and will reach King's Cross at 1.30 p.m., 6 min. later than at present; departure from Hull will be at 9.25 instead of 9.10 a.m., so that the up timing of 4 hr. 5 min. from Hull is unchanged.

An innovation of importance affecting Hull is brought about by a modification of the working of the West Riding Pullman, which, in view of the new Silver Jubilee service, will no longer work north of Harrogate. Instead, a section of the train is to work to and from Hull, and a stop is to be made in both directions at Doncaster to make the connection. The 4.45 p.m. down will cover the 156 miles to Doncaster in 157 min., and the 11 a.m. from Harrogate, altered to leave at 10.40 a.m., will run up from Doncaster in 156 min., at exactly 60 m.p.h. start-to-stop, reaching King's Cross at 2.40 p.m. In this way the 4-hr. timing between London and Harrogate remains unchanged despite the additional stop. The times of 45 min. from Doncaster to Hull, and 44 min. from Hull to Doncaster, over a 41-mile route with several severe service slacks, are faster than any previously scheduled, and make possible a time of 3½ hr. in each direction between London and Hull. The quickest time scheduled hitherto has been 3 hr. 52 min. down and 4 hr. 2 min. up for the 197 miles journey, so that this is a very substantial improvement. The 10.15 a.m. from Leeds to King's Cross is accelerated to arrive at 1.52 instead of 1.55 p.m., in order to leave 8 min. margin ahead of the up Silver Jubilee, due at 2 p.m. Another 5 min. cut is made in the time of the 1.20 p.m. from King's Cross to Edinburgh, now to be due at 9.5 p.m. at Waverley, in 7¾ hr. from London. This equals the time of the down Flying Scotsman, notwithstanding additional stops at Darlington and Alnmouth, and conditional stops at Drem and Dunbar. In Scotland the new fast restaurant car services from Aberdeen at 9 a.m. to Edinburgh, and from Edinburgh at 7.25 p.m. to Aberdeen, are to be retained.

A new evening express service will be provided on Sundays from Newcastle, Leeds, and Bradford to King's Cross, leaving Newcastle at 5.30 p.m. and Leeds at 6.45 p.m.; a non-stop run will be made over the 138·6 miles from Retford, and London will be reached at 10.45 p.m. On the Great Eastern section, from October 7, the Scandinavian express, connecting with the Esbjerg steamer, will leave at 3.10 p.m. (instead of 4.10 p.m.), attached to the 3.10 p.m. (hitherto 3.15 p.m.) express from Liverpool Street to Yarmouth, which will stop at Manningtree to detach the Parkeston Quay section. A new express service will be run from Norwich at 6.35 p.m. to Liverpool Street on Sundays, calling at Ipswich only, and due at 9.10 p.m.; a connection will be provided at Ipswich from Yarmouth and all stations on the East Suffolk line.

Great Western Railway

Additionally to the new Bristolian 1¾-hr. service between Paddington and Bristol, which, as reported in the September 6 issue of THE RAILWAY GAZETTE, came into operation on Monday last, further important improvements of G.W.R. services are announced to take effect in the winter timetable. The daily division of the Cornish Riviera service will continue, the Cornish Riviera Limited, at 10.30 a.m., calling at Exeter at 1.20 p.m. to pick up passengers only (which assumes a start-to-stop time of about 168 min. over the 173·5 miles from London), and reaching Plymouth (North Road) at 2.32 p.m., in 4 hr. 2 min. from London. This train will convey the Newquay, Falmouth, St. Ives, and Penzance portions only, and a second part, leaving at 10.35 a.m., will be through to Torquay and Kingswear—an innovation—and carry through coaches for Kingsbridge, Ilfracombe, Minehead, and Weymouth. The latter will, of course, include a restaurant car, and as a stop is to be made at Taunton, at 1 p.m., instead of slipping, Minehead and Ilfracombe passengers by this train will for the first time be able to obtain lunch *en route*. A valuable quickening will be obtained by starting the existing 4.30 p.m. down at 5.5 p.m., and running it non-stop to Bristol via Badminton in 2 hr.; at Bridgwater and beyond arrivals will be 13 min. later than at present—an acceleration of 22 min. in running. The 4.30 p.m. service will be continued, but from London to Weston-super-Mare only. In the reverse direction the 7.45 a.m. express from Torquay to Paddington, which hitherto has run on Mondays only, will become a daily train; it will start at 7.42 a.m., and a through portion in connection will be run from Plymouth at 7 a.m., providing a new morning service from Plymouth to Paddington. The 9 a.m. from Penzance to Plymouth is to be extended to London, running up 20 min. behind the Torbay Express, and arriving at 3.55 p.m.; the Torbay Express, at 12 noon from Torquay, will omit the Newton Abbot stop, and call only at Exeter, arriving at 3.35 p.m. The up Cornish Riviera Limited, resuming the customary Exeter call, will be due in London at 4.40 p.m., 5 min. earlier than hitherto in winter, and will complete a trio of express trains, at 12.40, 1.0, and 1.45 p.m. from Exeter, all making the 173·5-mile run to London in 175 min. The 11 a.m. from Swansea (12.10 p.m. from Cardiff) will stop at Swindon to set down, but without increase of journey time. The 1.55 p.m. express from Paddington to West Wales is this year to be continued throughout the winter, greatly improving the midday down service as compared with previous years.

Various services new this summer, such as the morning and evening business expresses between Manchester and South Wales, the new London-Oxford-Worcester-Hereford services, the streamlined railcars operating in the Oxford - Worcester - Malvern - Birmingham area, and the acceleration of the 7.50 a.m. Bristol-Paddington service, are being perpetuated. A valuable improvement of the Sunday morning service, during the winter, from Plymouth and South Devon to London is to be obtained by continuing to run the 10.15 a.m. from Plymouth non-stop to Paddington via Westbury, arriving at 3.10 p.m.

London Midland & Scottish Railway

Reference was made editorially in our August 23 issue to certain of the forthcoming changes in the L.M.S.R. timetables, and particularly to the first cut on record below 2 hr. of the principal services between Euston and Birmingham. These are the 9.10 a.m., 11.30 a.m., 2.25 p.m. (previously 2.20) and 5.50 p.m. down, now to be booked over the 94 miles from Euston to Coventry in 92 min.; and the 11.45 a.m., 1 p.m., and 2.35 p.m. up, which will be allowed 93 min. from Coventry, so permitting the London-Birmingham time in all seven cases to be reduced to 1 hr. 55 min. The 6.20 p.m. from Birmingham

to Euston, which calls at Coventry, Rugby, and Willesden, will nevertheless be booked to complete the journey in 2 hr., which will entail running the 65·1 miles from Coventry to Watford in exactly one hour. The express trains arriving in Euston at 3.10 p.m. (from Liverpool), 3.45 p.m. (the Lancastrian), and 4.5 p.m. (from Carlisle), will all be accelerated 5 min., and in the case of the Lancastrian this will require a time of 145 min. over the 145·9 miles from Stoke to Euston. The 10.30 p.m. Night Scot from Glasgow is to leave at 10.45 p.m., the 10.45 p.m. from Edinburgh at 10.55 p.m., and the 9.5 p.m. from Perth to London at 9.15 p.m., without increase of overall journey time. Other changes are relatively trivial. Several of the Luton-St. Pancras times on the Midland Division are cut to 30 min. for the 30·2 miles, but, as previously mentioned, an increase of 3 min. or so in the times of two of the same trains between Leicester and London more than nullifies any benefit so obtained. Similarly the new 60 m.p.h. schedules of certain West of England trains from Cheltenham to the service stop at Bromsgrove is not accompanied by any reduction of time between Cheltenham and Birmingham. Unlike the corresponding expresses of the L.N.E.R. between Edinburgh and Aberdeen, which are being retained in the timetables, the 3½-hr. morning Aberdeen-Glasgow service at 9.15 a.m., and the corresponding return express at 7.15 in the evening, are both withdrawn, except on Saturdays.

Southern Railway

There is little change to record in the Southern Railway timetables, as compared with last winter. The slight accelerations between Waterloo and Exeter and Waterloo and Bournemouth continue to operate, as also the 90-min. timings between Waterloo and Portsmouth. The full electric service introduced this summer to and from Eastbourne, Seaford, Bexhill, and Hastings is also permanent, except for certain minor modifications and the withdrawal of a few purely summer extra trains. New electric services are given from Woodside to Sanderstead, and over the Nunhead loop between Lewisham and St. Paul's.

CZECHOSLOVAK STATE RAILWAYS.—Traffic returns of the Czechoslovak State Railways for the first half of the current year show a slight improvement on the figures for the corresponding period of 1934. The total receipts amounted to 1,241 million crowns, compared with 1,212 millions a year ago. Passenger traffic produced 333 million crowns, an increase of 5·1 millions; the total freight carried was 17,900,000 tons, and the receipts from goods amounted to 859 million crowns, an improvement of 2·8 per cent.; express delivery of goods yielded 41·6 million crowns, an increase of abou 1 per cent. on the 1934 figure.

The Shipping, Engineering and Machinery Exhibition

As in previous years, many of the items on show at the Shipping, Engineering and Machinery Exhibition (Olympia, September 12-28), are of direct interest to the railway engineer, and reference is here made to some of them.

Sir W. G. Armstrong Whitworth & Co. (Engineers) Ltd. is showing an L.M.S.R. locomotive cylinder casting made from New Process pig iron, which has a tensile strength of 16-22 tons per sq. in. Other notable casting exhibits are a centrifugally cast nitrogen hardened (1,000 Brinell) locomotive cylinder liner by Sheepbridge Stokes Centrifugal Castings Co. Ltd., and automobile crankshafts in pig iron by the Ford Motor Company (selling agents, Stewarts and Lloyds Limited).

Stuffing boxes and packings of every type are exhibited by all the well known packing specialists, including the United States Metallic Packing Co. Ltd., and James Walker & Co. Ltd., while lubrication requirements are displayed by Tecalemit Limited, who has introduced the new Brentford range of oil lubricators for all classes of machinery, and C. C. Wakefield & Co. Ltd. The Caprotti valve gear is again a feature of the William Beardmore stand, and Auto-Klean Strainers Limited exhibits equipment for cleaning fuel and lubricating oil. Clensol boiler water softener and Noricene descaling fluid figure in the display of Clensol Limited.

Murex Welding Processes Limited has on view a steel underframe for a 12-ton covered goods wagon, fabricated at the Dukinfield works of the L.N.E.R. Equipment for welding and for metal cutting is also displayed by the Quasi Arc Co. Ltd., the British Oxygen Co. Ltd., which has arranged a comprehensive display of oxy-acetylene and electric arc welding sets and equipment, and Hancock & Co. (Engineers) Ltd.

Diesel engines bearing all the well-known names are to be seen, but the majority are of marine type. An exception is the 204-h.p. railcar engine by Gardner, with a Vulcan-Sinclair traction coupling. Twenty-seven of these engines are being supplied in cars for the Entre Rios and other South American railways. A two-stroke diesel engine of entirely novel design is shown by Tekon Development Limited. Known as the Stellar engine, on account of the star-like disposition of the cylinders round the crankshaft, it is said to have the highest output per swept litre of any diesel engine. Three railcars on the German State Railway are equipped with 210-350-h.p. Stellar engines. One of the radiators for eleven streamline diesel coaches under construction at the works of the Birmingham Railway Carriage & Wagon Co. Ltd., for the Entre Rios Railway, is shown by the Spiral Tube & Components Co. Ltd. This has sections for cooling water and lubricating oil. The company is responsible also for the radiators of ten new 330-h.p. Harland & Wolff engines for railcars. These have the Voith-Sinclair torque converter, and the radiators have sections for cooling the converter fluid. The radiators are arranged so that hot water can be by-passed to air conditioning units, and there are heat exchangers for supplying clean hot water to the lavatories. The principal exhibits of Davey, Paxman & Co. (Colchester) Ltd. are the two Paxman-Ricardo ranges of high-speed diesel engines, having outputs of 10-90 and 70-210 b.h.p. W. H. Allen, Sons & Co. Ltd. shows a 6-cylinder, 100 b.h.p. oil engine suitable for rail traction, and William Beardmore & Co. Ltd. a 185-225 b.h.p. 6-cylinder high speed diesel for similar duties. Other examples of diesel power are shown by John I. Thornycroft & Co. Ltd., Gleniffer Engines Limited, J. & H. McLaren Limited, and Norris, Henty & Gardners Limited.

The Vokes Protectomotor for diesel engines is prominently displayed, and a very useful range of rectifiers for battery charging, including a special type for the batteries of electric vehicles, electric plating, and other purposes is shown by the Westinghouse Brake & Signal Co. Ltd., while the Nife battery and portable lamps making use of it can be seen on the stand of Batteries Limited.

An interesting item on the stand of Babcock & Wilcox Limited is a full-size section of a B. & W. standard marine water-tube boiler, as used in the vessels of several British railways, while Thos. Firth and John Brown Limited has added to examples of high pressure hollow forged boiler drums a display of engineer's small tools, and high speed and alloy steels; lightweight alloys are represented on the stand of High Duty Alloys Limited. Specimens of fittings in Staybrite steel are shown by Firth-Vickers Stainless Steels Limited. Among the classes of screws, shown in typical applications, on the stand of Guest, Keen & Nettlefolds Limited, is the recently introduced Parker-Kalon hardened self-tapping type. As well as specimens of its well-known weighing machines, W. & T. Avery Limited shows rapid hardness, Brinell hardness, fatigue, and spring testing equipment.

SPECIFICATIONS FOR SIGNAL GLASSES AND LENSES.—The British Standards Institution has just issued two specifications for railway purposes, one dealing with colours for signal glasses, B.S.S. No. 623—1935, and the other for plano-convex (bullseye) lenses, B.S.S. No. 624—1935. Copies of these specifications may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. 2d. each post free.

XUM

NOTES AND NEWS

R.O.D. Re-Union Dinner.—Arrangements are being made for the next Re-union Dinner to be held at the Trocadero Restaurant on Friday, November 22.

New G.W.R. Halt.—A new halt at Little Drayton, between Tern Hill and Market Drayton, G.W.R., was opened last Saturday. It is served by all local trains.

The Brussels Exhibition.—The international jury at the Brussels Exhibition has awarded a *Grand Prix* to the joint exhibit of the Travel and Industrial Development Association of Great Britain and Ireland, and the British railways.

R.A.S. Winter Withdrawals.—Railway Air Services announces that the air services operating between Liverpool - Birmingham - Bristol - Southampton - Portsmouth - Brighton, and Nottingham - Birmingham - Cardiff-Torquay - Plymouth terminated for the 1935 season on Saturday, September 14.

Clyde Steamships Purchase.—It is reported that arrangements have been completed for the purchase of the business of John Williamson & Co., steamship owners, Glasgow, by the London Midland & Scottish Railway Company in association with David MacBrayne (1928) Limited, the transfer to take place at the end of the present month. The Williamson fleet consists of seven high-class turbine and paddle steamers.

Best Kept Stations, L.N.E.R.—Prizes in the Best Kept Stations Competition, L.N.E.R. (Southern Area), have been awarded to the following :—

Special, Class A : Saughall, Aldeburgh, Appleby, Leadenham, Elsenham, Willoughby.
Special, Class B : Ulceby, Trimley, Staveley Town, Crews Hill, Darsham, Sandy.
First Class : Gwersyllt, Chadwell Heath, Chettisham, Bealings, Fallowfield, Wretham and Hockham, Bush Hill Park, Lofthouse, Highams Park, Wrabness, White Notley, Spilsby.

Twenty-two stations have been awarded second class prizes, thirty-two third class, and fifty-eight fourth class.

French Passenger Tariff Revision.—Simplification is the key-note of the revisions in the French passenger tariffs just approved by the Minister of Public Works. Conditions and regulations will apply equally to all main line systems and will come into force on October 1. Some of their principal features are as follow : Tariff classification has been simplified, as have also formalities, especially as regards the stamping of certain tickets. There will in future be no limit to the number of breaks in a journey, and week-end fares will be reduced uniformly by 40 per cent. (up to 200 km.) and 50 per cent. (over that distance). A reduction of 50 per cent. will be effective in party travel tickets, and a lower supplement will be charged to holders of second or third class returns wishing to transfer to first class. All season tickets may be paid for in monthly instalments and be cancelled or modified if desired. Half-fare cards will be valid on any lines belonging to the main line systems selected by the passenger, for distances up to 1,500 km.

Classes in Transport Subjects.—Special provision is made by the North Western Polytechnic, Prince of Wales Road, N.W.5, for students who require classes in preparation for the examinations of the Institute of Transport. The fees are very moderate, and the new session opens September 23.

Cable Railway Project in Austria.—It is reported that work will begin early next year in Carinthia on a cable railway from the southern section of the recently opened Grossglockner mountain road, at an altitude of 8,000 ft., to the Fuscherkarkopff (10,500 ft.), where an hotel will be constructed. It will be the highest cable railway in the world, and at one point will cross a glacier for nearly a mile without a pillar.

Railway Club Lecture on Power Signalling.—The 1935-36 series of Railway Club monthly meetings was opened last Friday at the Royal Scottish Corporation Hall, Fetter Lane, E.C.4, by a lantern lecture from Mr. E. Wallis on "Power-operated Signals." Mr. Wallis also dealt with the uses of double-crank compensators and backing cranks in point and signal operation, and gave a concise and lucid explanation of track circuiting and relays.

Services at Briton Ferry, G.W.R.—From Monday next (September 23), the G.W.R. stations at Briton Ferry East and Court Sart will be closed, and trains from the Rhondda and Swansea Bay line will run direct to the new station at Briton Ferry. Trains proceeding to Swansea will at present continue to run to Swansea (East Dock), but by changing to the G.W.R. main line at the new Briton Ferry station, passengers for West Wales will avoid the change of station hitherto necessary there. Neath Riverside will also be closed, and passengers from Neath to the Rhondda will travel via Neath, G.W.R., and Briton Ferry.

Cheaper Travel in Italy.—A simple and practical scheme has been evolved by the Italian State Tourist Department (E.N.I.T.) of lowering the costs for visitors from abroad. The scheme embraces hotel coupons for accommodation at a reduced rate, special concessions on railway travel (up to 70 per cent. reduction), and—although perhaps we should not say so here—substantial reductions in the price of petrol for motorists. Other concessions, such as lower charges for visits to places of interest, are likely to be included in the final arrangements. The hotel coupons provide for "all-in" expenses, even including tips, at from 10s. to 22s. 6d. a day, the latter being for hotels de luxe. An attractive feature of this scheme is that it is not necessary to bind oneself beforehand to follow a fixed programme.

The Institution of Locomotive Engineers.—The opening general meeting of the 1935-1936 session of the Institution of Locomotive Engineers was held yesterday, Thursday, at the Institution of Mechanical Engineers, when the new President, Mr. A. C. Carr, V.D., delivered his Presidential Address, an abstract of which we hope to publish in our next issue.

Lighter Wagons by Welding, Canadian National Railways.—Steel coal wagons now being reconditioned in the C.N.R. shops, are being cut down and then rebuilt by welding, doing away with the rivets previously used. This method produces a steel wagon lighter in weight than the previous standard and capable of carrying a heavier load.

Suggested Canadian Transport Inquiry.—In his final broadcast address to electors on September 15, Mr. R. B. Bennett, the Canadian Premier, urged the necessity of subjecting the whole transport problem in the country, particularly as manifested in inter-railway and road *versus* air competition, to examination by the Economic Council authorised in the last session of Parliament. Were the council to recommend any form of amalgamation between the Canadian National and Canadian Pacific systems, he promised that the matter should be referred to the electors before action was taken.

Railway Services Delayed by Storm.—The gale of Monday night brought down trees across the Southern Railway lines at Blackheath, Sevenoaks, Hampton Wick, Hampton Court, Chertsey, Datchet, Forest Hill, and Epsom, causing some delay to early services. Signal wires were broken at Herne Hill. Sand swept on to the line between Barmouth and Barmouth Junction, G.W.R., derailed a locomotive at Quay Crossing, causing the suspension of services for several hours. Passengers from Barmouth for London and the North were taken by motorbus to Dolgelly station. The northern lines suffered to a smaller extent, and the gale retarded Anglo-Scottish services.

Belfast Omnibus Transfer.—Notice has been given by the Northern Ireland Road Transport Board of its intention to take over the undertaking of the Belfast Omnibus Co. Ltd. as from October 1 next. Subject to confirmation by the shareholders at an extraordinary meeting to be held at the Hotel Metropole, London, on September 25, the compensation to be received by the company has been agreed at £146,887 Northern Ireland Transport 4 per cent. A.1 stock, and £271,250 Northern Ireland Transport B stock, which bears interest at varying rates. Section 19 (7) of the Road and Railway Transport Act (Northern Ireland), 1935, provides that the B stock,

which ranks after the A stock, shall bear interest at a rate not exceeding 4 per cent. per annum in respect of each of the first two years after July 16, 1935, and 5 per cent. per annum in respect of each subsequent year, plus the right to receive in respect of any year in which there is a sum available out of the revenues additional interest not exceeding 1 per cent. per annum. The sum of £146,887 A stock will be subject to adjustment in respect of depreciation, &c. The company's issued share capital is £144,930, and it has outstanding £95,900 of 5 per cent. debenture stock.

Manila Railway Co. (1906) Ltd.—In a scheme to be put before debenture holders and shareholders of the Manila Railway Co. (1906) Ltd., an English holding company, at meetings to be held on October 3, the directors ask for power to sell to the Manila Railroad Company or the Philippine Government, but not after April 30, 1936, at the price of 80 per cent., payable in U.S. dollars in New York, the whole of the $8,170,000 Southern lines first mortgage gold bonds of the Manila Railroad Company. These bonds are charged to secure the A and B debentures and the 5 per cent. debenture stock of the English holding company. The net proceeds of the sale are to be utilised first in redeeming the 5 per cent. debenture stock at 85, any surplus to be used for redeeming the A debentures by purchase or tender.

Road Accidents.—The Ministry of Transport return for the week ended September 20, of persons killed or injured in road accidents is as follows. The figures in brackets are those for the corresponding period of last year :—

	Killed, including deaths resulting from previous accidents	Injured
England ...	127 (142)	4,347 (4,852)
Wales	8 (3)	197 (216)
Scotland ...	18 (14)	397 (487)
	153 (159)	4,941 (5,555)

The total fatalities for the previous week were 148, as compared with 160 for the corresponding period of last year.

British and Irish Traffic Returns

GREAT BRITAIN	Totals for 37th Week			Totals to Date		
	1935	1934	Inc. or Dec.	1935	1934	Inc. or Dec.
L.M.S.R. (6,925¼ mls.)	£	£	£	£	£	£
Passenger-train traffic...	519,000	525,000	− 6,000	18,539,000	18,127,000	+ 412,000
Merchandise, &c. ...	463,000	459,000	+ 4,000	16,359,000	16,286,000	+ 73,000
Coal and coke ...	217,000	214,000	+ 3,000	8,307,000	8,311,000	− 4,000
Goods-train traffic ...	680,000	673,000	+ 7,000	24,666,000	24,597,000	+ 69,000
Total receipts	1,199,000	1,198,000	+ 1,000	43,205,000	42,724,000	+ 481,000
L.N.E.R. (6,336 mls.)						
Passenger-train traffic...	348,000	354,000	− 6,000	12,052,000	11,759,000	+ 293,000
Merchandise, &c. ...	308,000	317,000	− 9,000	11,280,000	11,305,000	− 25,000
Coal and coke ...	212,000	224,000	− 12,000	8,074,000	8,294,000	− 220,000
Goods-train traffic ...	520,000	541,000	− 21,000	19,354,000	19,599,000	− 245,000
Total receipts	868,000	895,000	− 27,000	31,406,000	31,358,000	+ 48,000
G.W.R. (3,749¼ mls.)						
Passenger-train traffic...	232,000	230,000	+ 2,000	7,858,000	7,716,000	+ 142,000
Merchandise, &c. ...	189,000	187,000	+ 2,000	6,614,000	6,570,000	+ 44,000
Coal and coke ...	99,000	111,000	− 12,000	3,588,000	3,650,000	− 62,000
Goods-train traffic ...	288,000	298,000	− 10,000	10,202,000	10,220,000	− 18,000
Total receipts	520,000	528,000	− 8,000	18,060,000	17,936,000	+ 124,000
S.R. (2,171 mls.)						
Passenger-train traffic...	344,000	333,000	+ 11,000	11,460,000	11,138,000	+ 322,000
Merchandise, &c. ...	64,000	69,000	− 5,000	2,240,500	2,378,500	− 138,000
Coal and coke ...	29,000	30,000	− 1,000	1,080,500	1,132,500	− 52,000
Goods-train traffic ...	93,000	99,000	− 6,000	3,321,000	3,511,000	− 190,000
Total receipts	437,000	432,000	+ 5,000	14,781,000	14,649,000	+ 132,000
Liverpool Overhead ... (6½ mls.)	1,228	1,116	+ 112	44,362	42,746	+ 1,616
Mersey (4½ mls.) ...	3,975	3,886	+ 89	148,327	150,859	− 2,532
*London Passenger Transport Board ...	544,100	535,300	+ 8,800	5,908,900	5,824,900	+ 84,000
IRELAND						
Belfast & C.D. pass. (80 mls.)	3,420	2,890	+ 530	99,868	98,662	+ 1,206
,, ,, goods	542	492	+ 50	18,416	18,869	− 453
,, ,, total	3,962	3,382	+ 580	118,284	117,531	+ 753
Great Northern pass. (543 mls.)	11,850	11,450	+ 400	403,150	382,850	+ 20,300
,, ,, goods	9,350	9,350	—	332,500	316,750	+ 15,750
,, ,, total	21,200	20,800	+ 400	735,650	699,600	+ 36,050
Great Southern pass. (2,124 mls.)	28,566	26,716	+ 1,850	943,720	918,226	+ 25,494
,, ,, goods	36,570	33,392	+ 3,178	1,248,570	1,173,511	+ 75,059
,, ,, total	65,136	60,108	+ 5,028	2,192,290	2,091,737	+ 100,553

* 11th week, the receipts for which include those undertakings not absorbed by the L.P.T.B. in the corresponding period last year ; last year's figures are, however, adjusted for comparative purposes

British and Irish Railways Stocks and Shares

Stocks	Highest 1934	Lowest 1934	Prices Sept. 18, 1935	Prices Rise/Fall
G.W.R.				
Cons. Ord. ...	66½	48½	47½	−½
5% Con. Prefce. ...	118	109	112½	−2
5% Red.Pref.(1950)	115	107	108½	−2
4% Deb.	117	105	112	−1
4½% Deb. ...	119	109	115½	−2
4½% Deb. ...	129½	115¼	121½	−3
5% Deb.	135	126¼	133½	−1
2½% Deb.... ...	75	64	73	—
5% Rt. Charge ...	134 7/16	123¼	130½	−2
5% Cons. Guar. ...	132¾	121¾	123½	−3
L.M.S.R.				
Ord.	30½	19½	18	−½
4% Prefce. (1923)	64¼	41	51	−1
4% Prefce. ...	87	69½	79	−1
5% Red.Pref.(1955)	107	92½	100½	−1
4% Deb.	114 1/8	100½	103	−1
5% Red.Deb.(1952)	118 11/16	111¼	115½	—
4% Guar.... ...	106½	96¾	98½	−2
L.N.E.R.				
5% Pref. Ord. ...	24¾	13½	9½	−½
Def. Ord.	11½	6 7/8	5¼	—
4% First Prefce....	76	59½	55	−2
4% Second Prefce.	47	25½	20½	−½
5% Red.Pref.(1955)	94½	80	77½	−1
4% First Guar. ...	104	92	97	−½
4% Second Guar.	97 7/8	86½	87½	−1½
3% Deb.	90	74½	78	−1½
4% Deb.	114	99¼	102	−½
5% Red.Deb.(1947)	117	108	112½	−1
4½% Sinking Fund Red. Deb.	111¼	105¼	110	—
SOUTHERN				
Pref. Ord.... ...	90	63 1/8	77	−1
Def. Ord. ...	32 5/8	19	18½	−½
5% Prefce. ...	118 3/16	107½	112½	−2
5% Red.Pref.(1964)	115¾	107½	113½	−1
5% Guar. Prefce.	132	120¾	125½	−2
5% Red.Guar.Pref. (1957)	119½	113	115½	−1
4% Deb.... ...	116½	103¼	111	−1
5% Deb.	134	124 13/16	133½	—
4% Red. Deb. 1962–67	113 11/16	105 9/16	111½	−1
BELFAST & C.D.				
Ord.	6	5	8½	—
FORTH BRIDGE				
4% Deb.	110	100	107½	—
4% Guar. ...	110	100	106½	—
G. NORTHERN (IRELAND)				
Ord.	9¾	4 15/16	16½	+1½
G. SOUTHERN (IRELAND)				
Ord.	25	12½	40½	—
Prefce.	21½	13 15/16	44½	—
Guar.	48	39	78½	—
Deb.	67	59	79	−¾
L.P.T.B.				
4½% "A" ...	126	115	122½	−1
5% "A" ...	135½	124½	132½	—
4½% "T.F.A." ...	113½	107½	111	—
5% "B" ...	131¾	118	127½	—
"C"	97	73	102	—
MERSEY				
Ord.	15¼	7	11	—
4% Perp. Deb. ...	93½	82½	94½	—
3% Perp. Deb. ...	66½	61½	70½	—
3% Perp. Prefce.	54	44½	52½	—

XUM

CONTRACTS AND TENDERS

Large Wagon Order for South Africa

In addition to the orders secured by the Metropolitan-Cammell Carriage & Wagon Co. Ltd. for electric coaches for South Africa and goods wagons for India recorded in this column in last week's issue, this firm has now received an order from the South African Railways & Harbours Administration for a total of 950 general merchandise wagons. The order comprises 450 open drop-sided bogie wagons of type DZ6, fitted with Miner draft gear, and 500 4-wheeled open drop-sided wagons, type ES4, fitted with Waugh-Gould draft gear. Vacuum brake will be fitted throughout on this stock.

Taylor Bros. & Co. Ltd. has received an order for the whole of the wheels and axles required for the above stock.

The English Steel Corporation is to supply all springs, apart from drawgear, for the above stock, and the automatic couplers of the Visco-Alliance type will also be supplied by this firm. These orders, as also the electric coach and wagon orders referred to above and in last week's issue, have been secured in face of world-wide competition.

Jessop & Co. Ltd. has received an order from the Indian Stores Department for 40,000 ft. of point rodding at a total price of Rs. 10,625, free delivery Howrah.

Indian Imports of Railway Materials

In a survey of the import trade of India during the three months April 1-June 30, 1935, issued by the Department of Overseas Trade, it is recorded that there has been a considerable increase in the Indian imports of railway locomotives, from a total value of Rs. 7 lakhs for the quarter ended June 30, 1934, to Rs. 12 lakhs for the corresponding quarter this year. Imports from the United Kingdom, which is stated to have secured the bulk of this trade, advanced from Rs. 5¼ lakhs to Rs. 9½ lakhs. The figures for the quarter under notice and the corresponding quarter last year are, for the following items, respectively: railway locomotive engines and tenders, and parts, Rs. 12¼ lakhs, Rs. 7¼ lakhs; steam engines and parts, Rs. 3 lakhs, Rs. 2½ lakhs; oil engines and parts, Rs. ¼ lakh, Rs. 1 lakh; and boilers, Rs. 15 lakhs, Rs. 12½ lakhs. The share of the United Kingdom in the import of boilers into India increased from Rs. 11·5 lakhs to Rs. 12·5 lakhs in value. Increases were shown in the imports of rails, chairs, and fishplates, and a very marked increase, from 33 tons, value Rs. 0·06 lakhs, for June quarter, 1934, to 1,312 tons, value Rs. 2 lakhs, represented the United Kingdom share (practically the whole of the trade, which totalled 1,331 tons for the June quarter, 1935) of sleeper and steel and iron rail key imports.

J. Stone & Co. (India) Ltd. has received an order from the Indian Stores Department for 235 superheater elements at a total price of Rs. 13,790, free delivery Howrah.

Rolling Stock for Peru

The Birmingham Railway Carriage & Wagon Co. Ltd. has received orders from the Peruvian Corporation for 10 20-ton all-steel bogie covered goods wagons and 20 35-ton bogie flat wagons.

Nye & Menzies Limited, on behalf of La Bougeoise et Nicaise a Delcuve has also received an order from the Peruvian Corporation for 20 35-ton bogie flat wagons.

J. Baker & Bessemer Limited has received an order for 40 pairs of wheels and axles for the 20-ton all-steel bogie covered goods wagons for the Peruvian Corporation.

Taylor Bros. & Co. Ltd. has received an order for 160 pairs of wheels and axles for the 35-ton all-steel flat wagons for the Peruvian Corporation.

Locomotives for Egypt

Sir W. G. Armstrong, Whitworth & Co. (Engineers) Ltd. has received an order from the Egyptian State Railways Administration for 15 tank locomotives required for the Minia auxiliary railways.

Geo. Turton Platts Limited has received an order from the Bombay, Baroda & Central India Railway Administration for 200 broad gauge wagon buffers to the inspection of Messrs. Rendel, Palmer & Tritton.

Leyland Motors Limited has received the following orders from railway-associated road transport operators: Western Welsh Omnibus Company: 56 Tiger vehicles, including 36 oil-engined and 20 with all-steel bodies; and Ribble Motor Services Limited: 54 Tiger vehicles.

The Argentine State Railways Administration is calling for tenders, to be presented in Buenos Aires by October 16, 1935, for the supply of two electric capstans, 300 metres of cable, two fairleads and eight electric hoists. Further particulars of this call for tenders may be obtained from the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

The Controller of Stores, North Western Railway of India, Lahore, invites tenders receivable by October 30 for a special purpose machine to mill the ports in piston valve liners.

The Bombay, Baroda & Central India Railway Administration invites tenders, receivable at the White Mansion, 91, Petty France, Westminster, S.W.1, by September 25, for 159 steel structures of various designs for supporting the overhead contact system of an electric railway.

Forthcoming Events

Sept. 19–28.—"The Model Engineer" Exhibition, at Royal Horticultural Hall, Vincent Square, London, S.W.1.

Sept. 21 (*Sat.*).—Permanent Way Institution (Manchester-Liverpool), at Blackpool, 3 p.m. "The Permanent Way," by Mr. H. L. Douglas; "Removing a Building," by Mr. F. McCandlish.

Oct. 1 (*Tues.*).—Retired Railway Officers' Society, at Abercorn Rooms, Liverpool Street, London, E.C.2, 2.30 p.m. Ordinary Meeting.

Oct. 2 (*Wed.*)—Permanent Way Institution (Leeds), at Quebec House, Quebec Street, 7.30 p.m. "Some Permanent Way Problems," by Mr. R. Gurd.

Oct. 2–12.—International Exhibition of Inventions, at Central Hall, London, S.W.1.

Oct. 8 (*Tues.*).—Permanent Way Institution (Sheffield), at Royal Victoria Hotel, 7 p.m. "Activities at Redbridge Permanent Way Shops and Sleeper Depot," by Mr. S. G. Reed.

Oct. 9 (*Wed.*).—Institution of Railway Signal Engineers, at Inst. of Electrical Engineers, Savoy Place, London, W.C.2, 6 p.m. Ordinary Meeting.

Permanent Way Institution (London). "The Design of Retaining Walls," by Mr. H. Savage.

Oct. 12 (*Sat.*).—Permanent Way Institution (Manchester-Liverpool), at Temperance Inst., Southport, 3 p.m. "With a Camera in the Sudan," by Mr. C. A. Greenwood.

Oct. 14 (*Mon.*).—Institute of Transport (London), at Inst. of Electrical Engineers, Savoy Place, W.C.2, 5.30 p.m. Opening Meeting and Presidential Address by Sir Cyril Hurcomb, K.B.E., C.B.

Oct. 15 (*Tues.*).—Institute of Transport (London), at Inst. of Electrical Engineers, Savoy Place, W.C.2, 6 p.m. "Railway Transport in the Dominions," by Mr. A. W. Arthurton.

Oct. 25 (*Fri.*).—Institution of Railway Signal Engineers, at Criterion Restaurant, Piccadilly Circus, London, W.1. Annual Dinner.

Oct. 26 (*Sat.*).—Permanent Way Institution (Leeds), at Doncaster. Joint Meeting with Sheffield Section.

Exports of Railway Material from the U.K. in August

	Aug., 1935	Aug., 1934	Eight Months Ending Aug., 1935	Eight Months Ending Aug., 1934
	£	£	£	£
Locomotives, rail	74,671	24,590	468,151	194,619
Carriages and wagons	150,976	52,517	786,372	483,994
Rails, steel	115,762	189,404	563,910	706,401
Wheels, sleepers, fishplates and miscellaneous materials	245,752	111,144	1,265,870	713,831

Locomotive and rail exports included the following:—

	Locomotives		Rails	
	Aug., 1935	Aug., 1934	Aug., 1935	Aug., 1934
	£	£	£	£
Argentina	44,681	—	5,184	2,414
Union of South Africa	—	—	81,147	30,652
British India	14,988	3,228	58,044	35,429

OFFICIAL NOTICES

Sudan Government

SUDAN RAILWAYS require the services of a SIGNAL AND TABLET INSPECTOR, age not to exceed 32 years, preferably single. Candidates should have had workshop and outdoor experience in the maintenance and renewal of Signalling Installations, Tablet, Telephone and Telegraph Instruments on a Single Line Railway operated on a Block System with token instruments. Preference will be given to candidates able to prepare diagrams, interlocking tables and working charts.

Starting rate of pay £E400 per annum rising to £E520 per annum by biennial increases of £E20 per annum (£E1 = £1 0s. 6d.). Candidate will be required to subscribe towards Provident Fund at 7½ per cent. of salary.

The selected candidate will be required to leave for the Sudan at once. Free passage on appointment; strict medical examination.

Applications, giving full particulars of age, education and experience, with copies of testimonials, should be sent to: Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1, marking envelope "Signal Inspector."

Bengal-Nagpur Railway Company Limited

THE Directors are prepared to receive Tenders for:—

9,000 STEEL BOILER TUBES.

Specification and Form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad Street, London, E.C.2, on or after Monday, 16th September, 1935.

A fee of 10s. will be charged for each copy of the Specification, which is *not* returnable.

Tenders must be submitted not later than noon on Thursday, 26th September, 1935.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
T. R. WYNNE,
Managing Director.

University of London Commerce Degree Bureau

THE Official Institution of the University for the assistance of External Students preparing for the Commerce Degree Examinations of the University of London who are unable to attend regular College Lectures.

For prospectus apply to Secretary (Mr. H. J. Crawford, B.A.), 46, Russell Square, W.C.1.

PATENTS for Inventions, Trade Marks, Advice, Handbook, and consultations free. King's Patent Agency, Ltd. (B. T. King, C.I.M.E., Registered Patent Agent, G.B., U.S., and Canada). 146a, Queen Victoria Street, London, E.C.4. 49 years' references. 'Phone City 6161.

OFFICIAL ADVERTISEMENTS intended for insertion on this page should be sent in as early in the week as possible. The latest time for receiving official advertisements for this page for the current week's issue is noon on Thursday. All advertisements should be addressed to:—*The Railway Gazette*, 33, Tothill Street, Westminster, London, S.W.1.

The Model Engineer Exhibition

The seventeenth annual Model Engineer Exhibition was opened by Sir Josiah Stamp, Chairman and President of the Executive, L.M.S.R., yesterday (Thursday) at the Royal Horticultural Hall, Westminster. He was supported by, among others, Mr. Sidney Garcke, President of the Institute of Transport, and Mr. Percival Marshall, Editor, *The Model Engineer*. The exhibition will remain open daily between 11 a.m. and 9.30 p.m. until September 28.

In spite of the growing interest among model enthusiasts for aeronautics railway subjects predominate this year even more than in the past. There are a surprising number of comparatively large-scale models, mostly of locomotives. These "little giants" should cause the competition judges a considerable amount of thought. A new L.M.S.R. Stanier 4-6-0, however, looked most impressive. It was interesting to note two large Midland compounds—rarities indeed in these days of six-coupled engines.

The G.W.R. enthusiast may be a little disappointed, especially in view of that company's recent centenary, for this year the L.M.S.R. and L.N.E.R. seem to have claimed most attention from the model makers. Even the Southern Railway, usually one of the most favoured lines, seems to have suffered in this enthusiasm for northen prototypes. A number of unusual models nevertheless, have found their way on to the competition stands this year. For instance, there is a locomotive and train of the Isle of Man Railways, and two trains of early London & Greenwich, and L.S.W.R. stock. Apart from these and few other examples, there are few rolling stock models among the competition entries. For a really representative display in this category, the visitor has to turn to the club stands. On the Model Railway Club stand, for instance, there are some beautiful examples of model rolling stock, including a group of old Southern Railway pantograph suburban electric stock.

The exhibition usually provides a very fair reflection of the railway events of the past year, and this year's display —except for an inappropriate paucity in G.W.R. models—is no exception to the rule. The German railway centenary is recalled by a gauge-O model of the first train headed by *Der Adler* on one of the trade stands, and the L.M.S.R. experimental turbine locomotive provides the subject for another commercial model.

RAILWAY AND OTHER REPORTS

San Paulo (Brazilian) Railway.—Warrants for an interim dividend of 2½ per cent. on account of the year ending December 31, 1935, on the 5 per cent. non-cumulative preference stock will be posted on October 24. In consequence of the continued low rate of exchange, the directors have decided to await the result of working for the whole year before declaring any dividend on the ordinary stock. No interim ordinary payment was made last year; 2½ per cent., tax free, was paid for the whole year.

Darjeeling Himalayan Railway.—Gross earnings for the year ended March 31 last amounted to Rs.12,72,716, compared with Rs. 12,87,811 for 1933-34. Working expenses were reduced from Rs. 8,78,719 to Rs. 8,62,269, and net earnings rose from Rs. 4,09,092 to Rs. 4,10,447. The ordinary dividend of 2 per cent. takes Rs. 35,000, the sum of Rs. 70,000 is put to reserve, and the amount carried forward is Rs. 1,67,603. Goods traffic showed some improvement, but passenger traffic continued to fall off.

Trans-Zambesia Railway.—Gross receipts for the year 1934 were £125,174, against £158,986 for the previous year. Working expenses were reduced from £112,019 to £95,148, but the operating ratio rose from 70·45 per cent. to 75·41 per cent. Net receipts amounted to £31,026 against £46,966. The sum of £82,894 was received from the Nyasaland Government under guarantee. The tonnage carried was 62,384 tons, against 85,506 tons, the principal cause of the difference being that construction material for the northern extension of the Nyasaland Railways and for the Zambesi Bridge was 9,182 tons against 28,293 tons for the previous year.

Hawthorn (R. & W.), Leslie & Co. Ltd.—A profit of £23,194 was earned for the year ended June 30, 1935, compared with £16,157 for 1933-34. The dividend is increased from 4½ per cent. to 5 per cent., and £278 is transferred to reserve, which leaves £14,951 to be carried forward (against £9,949). The debentures were redeemed on May 31, 1935, and the premium of 10 per cent. paid in accordance with the trust deed has been charged against the leasehold sinking fund built up in connection with the debentures. The balance of £44,721 remaining in the fund is transferred to the general reserve.

REDUCTION IN CANADIAN EXPRESS FREIGHT RATES.—Substantial reductions in rates on long-haul heavy express shipments to western Canada became effective over the lines of all railway companies in Canada on September 2. The new rates represent a reduction of more than 20 per cent. Some time ago express rates on packages of 15 lb. and under were considerably reduced, but in order to take advantage of these rates shippers frequently found it necessary to split large shipments into small packages, entailing an increase in packing costs. This disadvantage is now removed.

XUM

Railway Share Market

The stock and share markets have remained under the influence of reports from Geneva regarding the Italo-Abyssinian dispute. The prevailing view on the Stock Exchange is that with its settlement there would be a general advance in securities. This explains the firmness of gilt-edged stocks, among which are prior lien stocks of home railway companies. Home railway prior charge stocks cannot be purchased on a less basis than an average yield of 3¾ per cent.

Among stocks of which there is a limited amount on offer at the present time are Great Western 4 per cent. debenture stock yielding £3 11s. per cent., Southern 4 per cent. debenture stock yielding £3 12s. per cent., L.M.S. 4 per cent. debenture stock yielding £3 17s. per cent., and L.N.E. 4 per cent. debenture stock yielding £3 18s. per cent. Guaranteed and also preference stocks can be bought to give yields from 4 per cent. to 5 per cent. Among higher yielding stocks in the junior class Southern preferred ordinary, which gives a yield of about 5⅛ per cent. on the basis of the 4 per cent. dividend paid for 1934, is easily first favourite, although it meets with some competition from the L.M.S. 1923 preference stock. Both stocks are expected to pay a higher dividend for 1935, and allowance has to be made for this prospect in estimating their current value. London Passenger Transport "C" stock is another stock which is currently in receipt of dividend, and possesses prospects of a higher return over the next twelve months. It reached a new high record this week.

In foreign railways most interest continued to centre in Argentine railway stocks, although irregularity of movement occurred this week on conflicting reports about the crop situation and the absence of rains. The higher price of wheat is a point of interest, and with the forthcoming issue of the reports and holding of the annual meetings, the market is looking for an expansion of interest. Cordoba Central first and second debenture stocks were active on unconfirmed market rumours that the Argentine Government has asked for an extension by one month of the period for making a decision respecting purchase.

Traffic Table of Overseas and Foreign Railways Publishing Weekly Returns

	Railways	Miles open 1934-35	Week Ending	Traffics for Week: Total this year	Traffics for Week: Inc. or Dec. compared with 1934	No. of Weeks	Aggregate Traffics to Date: Totals: This Year	Aggregate Traffics to Date: Totals: Last Year	Aggregate Traffics to Date: Increase or Decrease	Shares or Stock	Prices: Highest 1934	Prices: Lowest 1934	Prices: Sept. 18, 1935	Yield % (See Note)
				£	£		£	£	£					
South & Central America.	Antofagasta (Chili) & Bolivia	830	8.9.35	12,110	— 4,930	36	440,120	506,830	— 66,710	Ord. Stk.	26⅝	19	19	Nil
	Argentine North Eastern	753	14.9.35	9,618	+ 1,739	11	91,582	87,190	+ 4,392	,,	11	6⅞	6	Nil
	Argentine Transandine	111		—	—	—	—	—	—	A. Deb.	52	45	48	8 5/16
	Bolivar	174	Aug., 1935	5,600	+ 300	35	50,300	49,150	+ 1,150	6 p.c. Deb.	10	6½	10	Nil
	Brazil	—		—	—	—	—	—	—	Bonds.	13⅝	10 7/16	13	3 13/16
	Buenos Ayres & Pacific	2,806	14.9.35	71,110	+ 1,704	11	790,315	771,701	+ 18,614	Ord. Stk.	16½	8½	7	Nil
	Buenos Ayres Central	190	7.9.35	$136,500	— $14,600	10	$1,239,900	$1,354,900	— $115,000	Mt. Deb.	23	10	16	Nil
	Buenos Ayres Gt. Southern	5,085	14.9.35	132,531	+ 8,697	11	1,298,172	1,355,080	— 56,908	Ord. Stk.	35	22	19½	Nil
	Buenos Ayres Western	1,930	14.9.35	38,050	+ 4,833	11	441,384	463,537	— 22,153	,,	27½	18½	15½	Nil
	Central Argentine	3,700	14.9.35	121,022	+ 250	11	1,296,772	1,413,959	— 117,187	,,	23	13½	11	Nil
	Do.	—		—	—	—	—	—	—	Dfd.	14	7	6	Nil
	Cent. Uruguay of M. Video	273	14.9.35	7,637	— 8,857	11	90,337	182,640	— 92,303	Ord. Stk.	15½	3	4	Nil
	Do. Eastern Extn.	311	14.9.35	1,311	— 128	11	14,704	15,719	— 1,015	—	—	—	—	—
	Do. Northern Extn.	185	14.9.35	932	+ 146	11	11,378	8,928	+ 2,450	—	—	—	—	—
	Do. Western Extn.	211	14.9.35	747	— 73	11	7,741	6,776	+ 965	—	—	—	—	—
	Cordoba Central	1,218	14.9.35	29,590	+ 1,560	11	366,100	368,960	— 2,860	Ord. Inc.	6	3	2	Nil
	Costa Rica	188	July, 1935	13,730	— 4,451	4	13,730	18,181	— 4,451	Stk.	30⅝	23½	34	5 7/8
	Dorada	70	Aug., 1935	12,900	+ 1,600	35	93,300	81,500	+ 11,800	1 Mt. Db.	103	95	102½	5 7/8
	Entre Rios	810	14.9.35	12,578	+ 1,028	11	134,903	120,215	+ 14,688	Ord. Stk.	21½	12	9½	Nil
	Great Western of Brazil	1,082	14.9.35	5,700	— 2,400	37	268,000	277,600	— 9,600	Ord. Sh.	7/8	5/8	5/8	Nil
	International of Cl. Amer.	794	July, 1935	$328,485	+ $25,683	30	$2,960,671	$3,022,796	— $62,125	—	—	—	—	—
	Interoceanic of Mexico	—	—	—	—	—	—	—	—	1st Pref.	1/–	1/–	1/2	Nil
	La Guaira & Caracas	22⅝	Aug., 1935	3,855	— 75	35	31,425	29,820	+ 1,605	Stk.	12¾	7⅝	8½	Nil
	Leopoldina	1,918	14.9.35	20,799	— 8,710	37	631,202	808,132	— 176,930	Ord. Stk.	14⅝	7	3½	Nil
	Mexican	483	7.9.35	$232,900	+ $17,500	10	$2,399,300	$2,209,000	+ $190,300	,,	3¼	1½	1/2	Nil
	Midland of Uruguay	319	Aug., 1935	5,433	— 2,655	9	10,651	17,549	— 6,898	,,	1½	1/2	1½	Nil
	Nitrate	401	15.9.35	4,836	+ 928	37	105,970	98,973	+ 6,997	Ord. Sh.	32 3/32	51/–	2⅝	Nil
	Paraguay Central	274	14.9.35	$2,543,000	+ $1,582,000	11	$21,296,000	$10,808,000	+ $10,488,000	Pr. Li. Stk.	84	67	77½	7⅝
	Peruvian Corporation	1,059	Aug., 1935	74,684	+ 4,636	9	148,497	122,665	+ 25,832	Pref.	14½	8	9½	Nil
	Salvador	100	7.9.35	¢11,675	+ ¢3,375	10	¢119,486	¢99,571	+ ¢19,915	Pr. Li. Db.	75	70	65	7 11/16
	San Paulo	153½	8.9.35	21,667	— 1,808	36	904,297	984,023	— 79,726	Ord. Stk.	86	67	44	5 11/16
	Taltal	164	Aug., 1935	2,420	— 30	9	4,945	5,078	— 133	Ord. Sh.	2⅛	1 7/16	1½	6 11/16
	United of Havana	1,365	14.9.35	17,313	+ 1,678	11	195,436	191,369	+ 4,067	Ord. Stk.	6	2	2	Nil
	Uruguay Northern	73	Aug., 1935	570	— 445	9	1,182	2,071	— 889	Deb. Stk.	6¼	3	4½	Nil
Canada.	Canadian National	23,714	7.9.35	625,473	— 13,420	36	22,471,285	22,043,382	+ 427,903	—	—	—	—	—
	Canadian Northern	—	—	—	—	—	—	—	— 4 p.c.	Prep. Dbs.	78¼	51½	55½	7 5/16
	Grand Trunk	—	—	—	—	—	—	—		4 p.c. Gar.	104½	97¼	98	4 1/16
	Canadian Pacific	17,211	14.9.35	589,800	+ 1,400	37	16,800,800	16,910,200	— 109,400	Ord. Stk.	18 5/16	11 1/16	10½	Nil
India.†	Assam Bengal	1,329	20.8.35	29,798	— 4,139	20	455,522	564,804	— 91,282	Ord. Stk.	88½	72	90½	3¾
	Barsi Light	202	20.8.35	2,805	— 82	20	59,415	63,780	— 4,365	Ord. Sh.	10 4½	9 8¾	8 6½	6⅝
	Bengal & North Western	2,114	31.8.35	54,330	+ 5,586	21	1,062,003	1,080,730	— 18,727	Ord. Stk.	29 7½	26 2	29 8½	5⅜
	Bengal Dooars & Extension	161	20.8.35	3,018	— 1,831	20	47,459	55,103	— 7,644	,,	12 5¼	12 4	12 5½	5 9/16
	Bengal-Nagpur	3,268	10.8.35	151,350	+ 15,795	19	2,304,612	2,180,355	+ 124,257	,,	10 5½	9 6	10 11½	3 15/16
	Bombay, Baroda & Cl. India	3,072	10.9.35	167,100	— 24,150	22	3,418,500	3,467,400	— 48,900	,,	11 5	10 8½	11 3½	5 5/16
	Madras & South'n Mahratta	3,230	20.8.35	126,825	— 20,098	20	2,125,225	2,358,256	— 233,031	,,	13 1	12 2¾	12 1½	7 13/16
	Rohilkund & Kumaon	546	31.8.35	10,160	— 97	21	200,309	209,262	— 8,953	,,	26 3	25 0	29 2½	3½
	South India	2,526	20.8.35	98,711	— 12,620	20	1,599,781	1,640,842	— 41,061	,,	11 9	11 5	11 7½	6 13/16
Various.	Beira-Umtali	204	July, 1935	64,040	+ 1,806	43	640,305	519,179	+ 121,126	—	—	—	—	—
	Bilbao River & Cantabrian	15	July, 1935	1,129	— 1,393	30	11,034	12,982	— 1,948	—	—	—	—	—
	Egyptian Delta	622	31.8.35	6,539	+ 54	21	82,745	83,910	— 1,165	Prf. Sh.	21 5/16	1⅝	1¾	5 11/16
	Great Southern of Spain	104	7.9.35	1,632	— 482	36	64,256	75,371	— 11,115	Inc. Deb.	4	3½	3½	Nil
	Kenya & Uganda	1,625	Aug., 1935	168,864	+ 8,252	35	1,642,084	1,545,502	+ 96,582	—	—	—	—	—
	Manila	—	—	—	—	—	—	—	—	B. Deb.	50	33	40½	8⅝
	Mashonaland	913	July, 1935	111,714	— 4,769	43	1,159,674	956,615	+ 203,059	1 Mg. Db.	101	91¾	103½	4 11/16
	Midland of W. Australia	277	July, 1935	11,008	— 889	4	11,008	11,897	— 889	Inc. Deb.	100	93	94½	5 5/16
	Nigerian	1,905	27.7.35	21,373	— 521	17	418,256	428,158	— 9,902	—	—	—	—	—
	Rhodesia	1,538	July, 1935	199,144	+ 6,699	43	1,922,663	1,611,125	+ 311,538	4 p.c. Db.	104⅞	97½	104	3 13/16
	South African	13,225	24.8.35	$49,768	+ 18,894	21	11,385,836	10,330,544	+ 1,055,292	—	—	—	—	—
	Victorian	4,728	May, 1935	771,592	+ 6,634	48	8,734,254	8,481,557	+ 252,697	—	—	—	—	—
	Zafra & Huelva	112	July, 1935	11,227	+ 167	30	76,472	76,861	— 389	—	—	—	—	—

NOTE.—Yields are based on the approximate current prices and are within a fraction of 1/16

† Receipts are calculated @ 1s. 6d. to the rupee. § ex dividend. Salvador and Paraguay Central receipts are in currency

The variation in Sterling value of the Argentine paper peso has lately been so great that the method of converting the Sterling weekly receipts at the par rate of exchang has proved misleading, the amount being over estimated. The statements from July 1 onwards are based on the current rate of exchange and not on the par value

Electric Railway Traction

Improvements in Suburban Trains

REGULAR travellers in electric suburban trains on the whole are a healthier, happier lot than their more unfortunate brethren who travel to and from business in steam-hauled locals, but there are still many ways in which multiple-unit suburban trains might be improved for the benefit of both passengers and owners. It is strange that comparatively little advance is made in the design of such trains, and the standardisation fetish almost seems to reach its peak in this type of rolling stock. As a general rule the trains are inordinately heavy, and the power required for rapid acceleration (always great) is higher than it need be. The acceleration rates used in everyday work are far lower than the designed figure, and the use of lighter bodies and underframes would enable the design figure to be approached more closely without any change in the electrical equipment. In reducing the weight it does not follow that the strength will be reduced. Indeed, some of the light all-metal trains now being used in more or less isolated cases, are stronger than the trains they replaced, stronger as regards resistance to tractive and running stresses, and stronger as regards resistance to passenger pressure. Aluminium and stainless steel mechanical portions are used on the Continent and in the U.S.A., and in certain examples the weight reduction has allowed of higher acceleration rates with reduced motor capacity. But if acceleration rates exceeding something like 2·0 m.p.h. p.s. are to be used in normal work some type of finely-regulated control will be necessary to prevent discomfort to the passengers. An improved type of braking, too, would not come amiss, even with present deceleration rates, but a distinct improvement could be made here by a closer supervision of the driving, and an insistence on the final release of the brake before the actual stop being made in a proper manner. The elimination of noise is a further point which might be given some attention, and fortunately a great improvement can be effected cheaply by the use of rubber inserts beneath the bogie pivot and sidebearers and at certain other points where steel to steel contact is made while running.

Corrosion of Conductor Rails

REDUCTION in the corrosion of conductor rails is a problem which the engineers of an electrified railway are constantly facing, although, with an average rail life of over 20 years, it is obvious that the question is not one of extreme urgency. Trouble may be experienced at widely separated parts of the line, depending upon local characteristics, or at two or three points within a couple of miles or so with no change in conditions. It is, of course, particularly prevalent where the line runs alongside the sea, and occasionally also where the route is along the bank of a large river. Equally serious corrosion may take place in tunnels through which both steam and electric trains are worked. A change in the specification governing the composition of the rail material may reduce corrosion under both of the above-mentioned headings, but this cannot be done without sacrificing something in the way of conductivity. A high sulphur content appears to be associated with rapid wear of the conductor rails, and so does segregation, although this feature is more common in the rails laid down 20 to 30 years ago than in modern rails. From investigations on old rails it would appear that in the early days of low-voltage electric traction more attention was paid to wear-resisting qualities than to the conductivity and the possibilities of corrosion. Yet although modern rails as a rule are superior in the two last respects, certain specifications now used in this country allow a greater silicon content than is found in most old rails, and this element increases the electrical resistance. On the other hand, the sulphur, phosphorus, and manganese contents are distinctly lower than in old rails which have had to be replaced owing to corrosion. Treating the conductor rails by painting or pickling has been tried, but has not justified the expenditure. It is rare for a conductor rail to have a life of less than 20 years, and even on heavily-trafficked lines like the Metropolitan and the District, a life of 25 years is not uncommon.

Electrification Efficiency

STRIKING examples of the efficiency of electric traction are contained in an article on the rationalisation of the Swedish State Railways published in the recent quarterly report of the Skandinaviska Kreditaktiebolaget. At the end of 1934, electric traction was applied to 3,231 track-km., or 43·5 per cent. of the State Railway's total, but the electric train-km. amounted to 28,020,000, or 70·4 per cent. of the total, while the wagon-axle km. amounted to 79 per cent. of the total. Of course, the electrification included the two principal main lines, Stockholm-Gothenburg and Södertalje-Malmo, but the traffic over these lines has increased since conversion, and forms a larger proportion of the whole than in steam-worked times. For instance, on the Stockholm-Gothenburg line the number of passengers carried increased by 15 per cent. during the first two years of electrification, while the increase on other lines was limited to 5 per cent. This was due to the cleaner and more frequent service and to the faster travel, the saving in time being from 2 to 2½ hr. on the 285-mile journey. The traffic capacity of an electrified line was shown in a remarkable manner in 1929. For six weeks the Copenhagen Sound was practically blocked with ice, and the harbours of Malmo, Hälsingborg, and Halmstad completely closed. The result was tremendous congestion on the Stockholm-Gothenburg line, and nearly 300 special goods trains had to be worked in, the goods traffic between Gothenburg and Hallsberg increasing by 200 per cent. Many of the electric locomotives were in effective service for 43 hr. out of 48 hr. almost throughout the period of blockage, and the whole of the extra traffic was worked with comparatively little additional cost and with an effectiveness which could not have been approached with steam traction, although the route is by no means heavily-graded or difficult to operate under normal conditions. The electrification of the Swedish State Railways was carried out primarily with a view to using the water power resources of the country and restricting the import of foreign fuel, which was erratic both in price and delivery, especially in times of international complications, but the present electrified network represents a considerable addition to the real wealth of the country, with effects reaching far beyond the fuel problem.

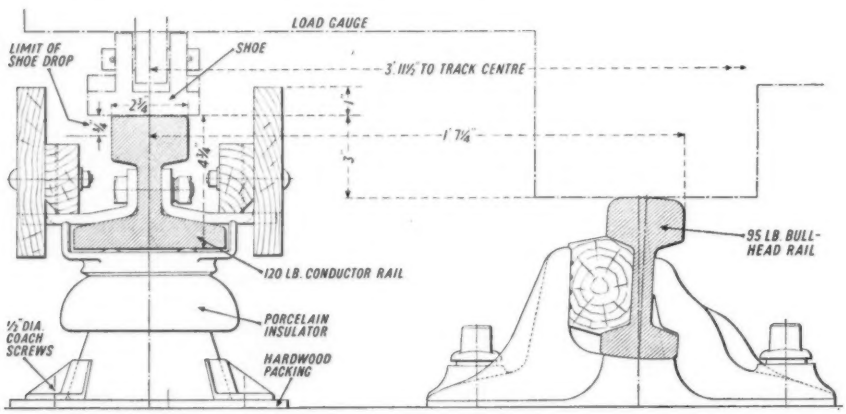
XUM

THE THIRD RAIL CONDUCTOR SYSTEM FOR ELECTRIC TRACTION

By A. G. HOPKING, Electrical Engineer's Dept., L.N.E.R.

IN the earliest examples of current collection for electric vehicles ordinary rails were used and were mounted on impregnated wood blocks. On the City & South London Railway an early form of conductor rail weighed 10 lb. a yd., whereas today certain sections of the Southern Railway have third rails weighing 150 lb. a yd. in lengths of 45 ft., and 100 lb. rails in 60 ft. lengths.

During the period represented by the above increase of size, some attempt has been made to standardise the position of the conductor rail relatively to the running rails. In 1903 the Railway Clearing House standardised 19¼ in. as the distance from the centre of the third rail to the gauge line, and the conductor rails of the L.N.E.R. Tyneside lines are placed in this position. The majority of the other electrified systems of the country, however, have adopted 16 in. instead of 19¼ in., following the lead of the London underground lines, where space was restricted by tunnels. A contact surface height above track rails of 3 in. was suggested in 1903, and has been adopted by the majority of lines, the Tyneside being an exception with 3¼ in. The usual tolerance allowed is plus or minus ¼ in. The Railway Electrification Committee of 1927 recommended 16 in. and 3 in. respectively as the dimensions for top contact rails, and 16 in. and 1½ in. for under contact conductor rails.



Layout of the new 120 lb. conductor rails now being laid on the 600-volt d.c. Tyneside electrified lines of the L.N.E.R. The same arrangement will be used in the electrification of the South Shields line, which was authorised recently

In the case of the lines of the London Passenger Transport Board an insulated fourth rail was adopted, acting as a negative conductor in place of the track rails, partly to leave the running rails clear for track circuiting, and partly to provide an effective insulated return so as to avoid possible electrolytic damage due to leakage currents. The height of this rail has been made 1½ in. above the running rails so that the negative shoe gear will remain above the running rails at crossovers, and at the same time keep the fourth rail below coupling chains and positive shoe gear on the rolling stock. The third rail is discontinued through crossovers where the negative shoe gear otherwise might foul it.

A fourth rail system is not likely to be used other than for short extensions of the existing lines of the London Passenger Transport Board, but on the Lancashire & Yorkshire section of the L.M.S.R. and in places on the Southern Railway and the Tyneside section of the L.N.E.R. a standard running or conductor rail is placed between the running rails and bonded to them so as to increase the conductivity of the uninsulated negative return circuit. In other instances, due to the proximity of gas and water pipes, or the lead sheath of power cables, which might suffer electrolytic damage if much current leaked away from the traction system, the fourth uninsulated rail has been installed to reduce the return current volt drop to a minimum. In nearly every instance where the track rails provide the return circuit they are not earthed at the substation. In certain cases the signal engineer has wished to put down a length of track circuit without the expense of impedance bonds, so one running rail has been given up and insulated for this purpose, and its place in the return path for traction current taken by an additional rail bonded to the other running rail.

The problem of the interrunning of trains between a system using one type of collection and another using some different arrangement is a wide one that is beyond the scope of this article, but one that may well have to be solved in this country. Main line locomotives built with pantographs for collection from a 1,500-volt or 3,000-volt overhead system might have to run into their terminal stations over a suburban network where 600-volt third rail collection is installed; or trains from a third rail track-return system might require to run over lines equipped with third and fourth rails. It will be clear that for a considerable service of insulated fourth rail trains to run over a short route of track return line the only provision necessary is an uninsulated fourth rail of the required height to be mounted on the sleepers and bonded to the running rails at intervals; but if the route were long and trains few, then it would be better to leave the track alone, and make arrangements for switching over the negative of the train equipments to earth on the underframes and bogies.

Three forms of positive collector rail have been developed. For pressures up to 660 volts a flat-bottomed Vignoles section rail is used, with Jarrah protection at level crossings and stations. For higher voltages it is preferable to use either the side contact system, such as used on the Manchester-Bury section of the L.M.S.R. and on certain lines in South America, or an under contact system as used on the New York Central Railroad. It is unlikely that any extension of the third rail working in

Track layout showing track feeders, third rails and impedance bonds on the Southern Railway

this country will employ either the side contact or the under running shoe gear, as engineers generally regard the extra cost and complication not justified by the slight additional safety of permanent way staff and the immunity of the trains from collection troubles in frosty weather.

Today the third rail is mounted on vitrified porcelain insulators at intervals of 12 ft. or less, held down to the sleepers by malleable iron clips and coach screws, with a malleable iron cap under the conductor rail. The friction between the collector shoe and the rail causes the rail to creep, and attempts have been made to prevent this by anchoring it to special insulators every 50 or 100 yd. Unfortunately so much force is involved that anchor insulators get broken if of the pedestal type. An insulated tie between conductor rail and sleeper is better. On some lines no attempt to anchor is made, and in this case certain lengths of rail have been found to creep as much as 4 ft. in a year; therefore all conductor rails must be watched and jacked back into position at frequent intervals. This creep is in the direction of traffic, and may take place with or against the gradient.

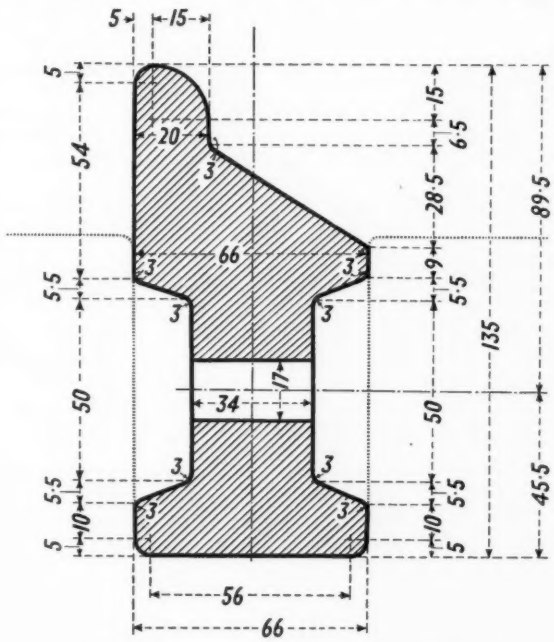
Insulation of Feeder Cables

Feeder cables to the conductor rail and jumper cables between sections of third rail need good insulation and frequent inspection. Lead covering is not recommended. Bad connections will cause local heating which in turn will result in the melting of snow or drying up of moisture in the faulty places, so giving warning to the maintenance staff. Other work that must be undertaken by a regular maintenance gang is the fitting of wooden packing insulators to take up rail wear, the cleaning of insulators to prevent conduction of current which causes heating and cracking, and the greasing of fishplates. Insulators can be cleaned with hydrochloric acid or petrol, then washed over with water and dried. Cleaning should be carried out when the insulation resistance of third rail, under normal conditions, drops to 6 or 12 megohms per mile.

It has already been mentioned that a conductor rail section of 150 lb. a yd. has been used, but a more usual weight today is 100 or 120 lb. for conductor rails, and 95 lb. for track rails. A conductor rail usually has a specific resistance of $6\frac{1}{2}$ to $7\frac{1}{2}$ times that of copper, while the resistance of the running rail is about 50 per cent. more than this. The new 60 ft. conductor rail on the Tyneside lines weighs 120 lb. and is of flat-bottomed section, the sectional area being 12 sq. in., equivalent to 1·85 sq. in. of copper. This may be compared with the resistance for pure iron, which would be equivalent to 2·07 sq. in. of copper. An average figure for the resistance of an 80 lb. conductor rail including bonding is 0·040 ohms per mile, and for one 95 lb. running rail, including bonding, 0·052 ohms per mile, but wear, corrosion and vibration have considerable effect on the average resistance of rails and bonds.

Longitudinal bonds for conductor rails are designed in the first instance to give a resistance for 3 ft. of rail including the bonded joint, equal to 6 ft. of unbroken rail, and the 1927 Committee recommended that the resistance of bonded joints should not be allowed to become greater than the equivalent of 10 ft. of unbroken rail. There is no doubt that in some cases conductor rails are left in service when their conductivity has been reduced to as little as 50 per cent., while 70 per cent. is quite a normal practice. The effect on the speed of trains, lighting and losses is so important that for every section of line a decision should be reached on this point of replacement, and rails that have reached the agreed minimum section should be replaced. Generally in sidings a greater reduction of section can be allowed before replacement than on the main running lines.

The life of a conductor rail has been variously stated as anything between 20 and 50 years, and one authority considers that about half the reduction of section is due to wear and a half due to corrosion, but corrosion is accelerated by smoke from steam trains and by salt air, and in such cases the effect of wear due to collector shoes is of relatively small importance. Undoubtedly the life of the rail will be shorter in stations, where heavy starting currents are taken always at the same place, than on sections where trains usually coast.



Cross-section of third rail used for the 1,500-volt suburban lines of the P.O.-Midi Railway

There must be a ramp at the termination of each length of rail, with a gradual slope so that the oncoming collector shoe will mount it without undue shock. The inertia of a heavy shoe at high speed will tend to accentuate this

bouncing, causing an interruption to the collection of current or breakage of the shoe gear. This ramp may be formed by bending down the end of the conductor rail 2 or 3 in., the inclination starting from 3 to 4 ft. from the end; alternatively a separate end nose may be bolted on.

Some experiments have been made with the chemical composition of conductor rails with a view to improving their resistance to corrosion, but the conclusion reached was that an improvement of resistance to corrosion would involve an increased cost and lower conductivity. Comparative figures for the chemical constituents of conductor and running rails are given as a rough guide, but a specification for conductor rail of given weight should leave the steel maker free to produce a rail of the required conductivity and as high a resistance to wear and corrosion as possible.

Material	*C.*	*Mn.*	*P.*	*S.*	*Si.*
Conductor rail, per cent.	0·05	0·2	0·05	0·05	Trace
Running rail, per cent.	0·35	1·0	0·07	0·8	0·1

The tendency during the last 20 years or so has been to increase the carbon content from 0·1 to 0·3 per cent., and reduce that of manganese from 0·35 to 0·10 per cent., that of phosphorus from 0·05 to 0·02 per cent., and that of sulphur from 0·08 to 0·03 per cent., the silicon content is kept as low as possible, only a trace being permitted.

One of the disadvantages of top contact third rails is their vulnerability in winter to sleet, ice and snow. A thin film of ice on the top surface of the conductor rail acts as an excellent insulator, and no really satisfactory method has been evolved for dealing with the problem. Brushes, scrapers, cutters, steam jets have all been tried, but still certain unfavourable weather conditions are liable to cause considerable dislocation of traffic. In this respect, the under contact or side contact rail would be very much more satisfactory, but clearances are so restricted that in many cases it would be impossible to instal either arrangement, even if the additional cost were not considered prohibitive.

On certain lines trouble from ice has been restricted by spraying the conductor rail with a lubricating oil, paraffin, or saline liquid of low freezing point. A heavy current at low voltage could be passed through the third rail to raise the temperature above the surrounding air enough to prevent freezing of snow or water in the surface, but each track mile of 80 lb. third rail would require over 4 B.O.T. units, equivalent to over 300 amp. for an hour to raise its temperature 1° F. neglecting radiation and conduction, which would make this method very inefficient.

NOTES AND NEWS

Reichsbahn Locomotive Orders.—The German State Railway has on order 27 electric locomotives for delivery during the first half of 1936.

Paris Suburban Electrification.—Among the works now being carried out by the French State Railways is the prolongation of the 650-volt d.c. suburban line from Bois-Colombes to Argenteuil and erection of a rotary converter substation at the latter station.

Swedish Extension.—The 97-mile section of the northern main line from Krylbo to Bollnas is to be opened to electric traction this month. It forms a northern extension of the Stockholm-Upsala-Krylbo line, the electrification of which was finished about nine months ago.

Bulgarian Electrification.—The Bulgarian Government has approved schemes for the electrification of the lines of the State Railways from Sofia to Pernik and from Sofia to Mesdras, and the work will be put in hand after suitable financial arrangements have been made.

Regenerative Braking Tests.—The P.O.-Midi Railway has been conducting regenerative braking tests with the 3,750-h.p. 2-Do-2 electric locomotives between Limoges and Brive. Without recourse to the air brakes, it was found possible to hold a 900 tonnes train on a grade of 1 in 100 at any speed between 25 km.p.h. (15·5 m.p.h.) and the maximum of 85 km.p.h. (53 m.p.h.) permitted over this steeply-graded and sharply-curved section. The use of regenerative braking to hold the train to the speed required by normal schedules resulted in a reduction of 16 per cent. in the energy consumption.

New Southern Electric Services.—Beginning on September 30, a proportion of the Mid-Kent electric trains are being extended from Woodside to Sanderstead, three miles, *via* Selsdon Road. The connecting line between the Mid-Kent and the Oxted Lines, for many years used only for goods and special through passenger services, has been electrified for the purpose, and two new stations built at Coombe Road and Bingham Road. An electric service will also be introduced between Lewisham and St. Pauls, over the newly electrified Nunhead-Lewisham loop.

Possible Jugoslav Electrification.—Consideration is being given to detailed estimates drawn up by the Jugoslavian State Railways for the conversion of the line from Zagreb to Cakavac.

Paris-Le Mans Signalling.—The Paris-Le Mans main line of the French State Railways, now in course of electrification on the 1,500 volts d.c. system, is to be fitted with automatic block signalling of the colour-light pattern operated by track circuits. The electrical apparatus for the signalling will be housed in the 11 traction substations down the line.

Welded Locomotive Frames.—Frame structures for many electric locomotives in Germany are now being fabricated by welding. The 56-ft. frame, complete with cross-stretchers and buffer beams, for the new 1-Do-1 locomotives of the Reichsbahn (illustrated elsewhere in this issue) weighs 12·5 tonnes, or about 19 per cent. less than a riveted frame. The welding up of the cab structure also has been practised to some extent.

Copenhagen Suburban Results.—The financial results of the Danish State Railways for the year ending March 31 last show that the additional receipts over the Copenhagen electrified lines increased by 1,950,000 kr. and the operating expenditure by 1,240,000 kr. The balance of 710,000 kr. represents about 5½ per cent. to cover interest and depreciation on the capital involved, which amounts to approximately 13,000,000 kr. It must be remembered that the electrified lines were not open throughout the year, the first section being opened on April 1, 1934; the second on May 15, 1934; and the third on November 1 of the same year. A further electrified section, that out to Holte, will be opened about May, 1936.

THE PARIS—LE MANS ELECTRIFICATION

Five million pound main line conversion on the French State Railways

FOLLOWING the recommendations of the Marquet plan, announced by the French Government last year to assist in relieving unemployment by large public works schemes, the French State Railways are proceeding with the electrification of the Paris-Le Mans main line at a cost estimated to be 403 million fr., of which 175 million fr. are to be expended in the purchase of rolling stock. The other 228 million fr. do not include the cost of modifications to the approaches to Montparnasse, but cover civil engineering works down the line. The electrification is being carried out on the French standard 1,500 volts d.c. system, with overhead contact lines.

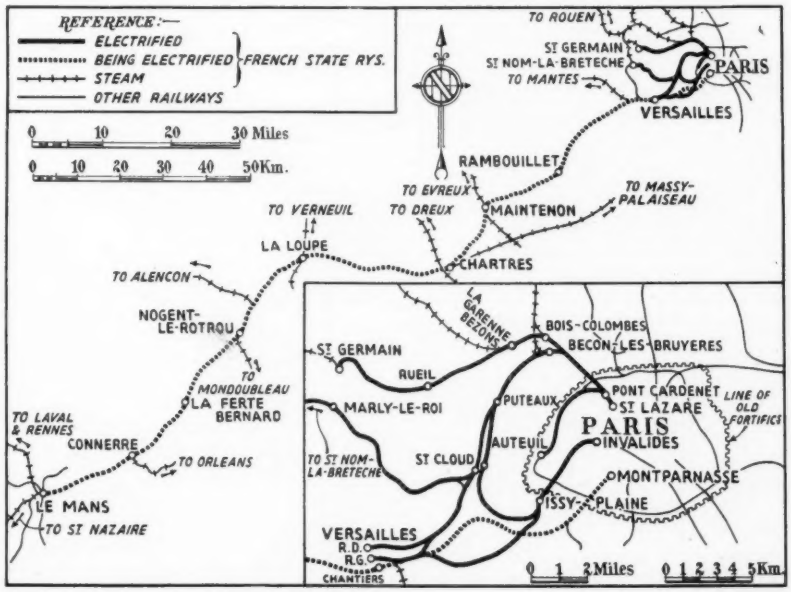
Power is to be supplied from the Paris steam plants and from the hydro-electric stations in the Dordogne, but the feeder voltage to the substations varies a good deal. At Le Mans the substation is close to an existing transformer station, and will be fed with three-phase current at a tension of 33 kV.; onwards to Chartres the substations will receive 90 kV. current from two parallel feeders, one from Eguzon, the main transforming station of the Dordogne plants, and the other from Chaingy, near Chartres, a transforming station of the Paris steam network. Between Chartres and Versailles the high-tension supply is at 60 kV. from the steam power plants, and the two substations located between Versailles and the Montparnasse terminus will be extensions to existing substations of the Etat's Paris suburban lines.

There are eleven automatically-operated substations over the 131 miles from Paris to Le Mans, spaced at distances varying from 11 to 15½ miles. An endeavour was made to locate them at railway stations as far as possible, and they are situated (as shown in the accompanying map) at Ouest Ceinture, Porchefontaine, La Verriere, Gazeran, Jouy, St. Aubin-St. Luperce, La Loupe, Nogent le Rotrou, La Ferté-Bernard, Pont de Gennes, Le Mans. The first two substations have a capacity based on the passage of 12 trains an hour, and in each are installed three groups of 2,750 kW. mercury arc rectifiers, one of which is normally in reserve. The remaining nine substations each have two 2,000 kW. rectifier sets with room for the installation of a third should this be required in future.

The overhead line construction, now being erected, is of the semi-rigid catenary type used on the P.O. electrified lines. The contact wire is of hard copper, 12·2 mm. in diameter; the main catenary is of cadmium bronze 14 mm. in diameter, and the auxiliary catenary of copper 11·5 mm. in diameter. The normal span between the masts is 206 ft., and on curves sharper than 2,300 ft. radius, 118 ft. The distance between the stringers averages 14 ft. 9 in. The maximum tension in the main catenary is 5,100 lb., in the auxiliary catenary 2,750 lb., and in the contact wire 3,750 lb. The presence of this overhead construction has involved the rebuilding of numerous bridges and stations, and opportunity has been taken to remodel the whole or part of the layout at certain points, notably at Clamart, Sèvres, Trappes, Chartres, and Le Mans, and at Rambouillet, the terminus of the suburban services. When the present quadrupling between Clamart and Porchefontaine is finished, the Etat will have four electrified tracks from Paris as far as Trappes, 17 miles. Large yards at Montrouge-Châtillon, Vaugirard, Trappes-Triage, Chartres, Le Mans, and Versailles are to be electrified also, making a total track mileage electrified of 435 compared with the 131 route miles.

The motive power required is to be of four types, *viz.*, express locomotives with a maximum permissible speed of 93 m.p.h.; general service locomotives with a top speed of 60 m.p.h., suitable for *trains-omnibus*, long-distance night trains which are slower than the day-time expresses, and goods trains; multiple-unit trains with a top speed of 60 m.p.h. for service between Paris and Chartres; and light motor-coaches with a top speed of about 60 m.p.h. for stopping services between Chartres and Le Mans. It is possible that a fifth type will be introduced in the form of a small number of light-weight high-speed motor coaches with a top speed of 93 m.p.h. for a special direct service between Paris and Le Mans.

Both locomotive designs are to be based on the types operating on the P.O. electrified lines. The express units will be of the 2-Do-2 type with an hourly rating of approximately 3,750 h.p. and a continuous rating of 3,300 h.p. They will be suitable for hauling 500-ton trains on the level and 240-ton trains up a grade of 1 in 166 at a speed of 90 m.p.h. They will be fitted with the Brown Boveri system of individual axle drive, 69-in. wheels, and will scale 135 tonnes, of which 80 tonnes will be available for adhesion. In view of the level character of the route, regenerative braking will not be incorporated. The general service locomotives are to be of the Bo + Bo type with an hourly rating of 1,740 h.p. and a weight of 80 tonnes.



Map of Paris - Le Mans and Paris suburban lines of the Etat

PROTECTION OF TELEPHONE AND TELEGRAPH CIRCUITS ON A SINGLE-PHASE RAILWAY*

Special apparatus for preventing interference

ONE of the first electric railways in Austria-Hungary was that between Gross Schwechat and Kittsee, on the route from Vienna to Pressburg (now Bratislava). It was constructed on the 16 kV. 16⅔ cycles single-phase system, but this supply now terminates at the Czecho-slovak frontier. The local lines connecting it to Vienna and Bratislava are worked at 600 V. d.c. The standards carry, in addition to the contact lines, a feeder at the same voltage, and in some places a three-phase 16 kV. 50-cycle industrial supply. The track rails are not bonded throughout, but a special return conductor is provided for 27 of the 30 miles total length, and is connected to all overhead poles and to the rails at each end of the section.

The telegraph and telephone circuits are carried on a wooden pole line, kept as far as possible from the 16 kV. lines; in some places it has been impossible to get more than 3 m. (9 ft. 10 in.) between them. There are one telephone and one Morse circuit connecting all stations and extending to Vienna, and a station-to-station telephone line, which also connects with all watchmen's and gatemen's huts. Special switch arrangements allow of this wire being used to communicate with the power house in an emergency. There is much fog and mist at times

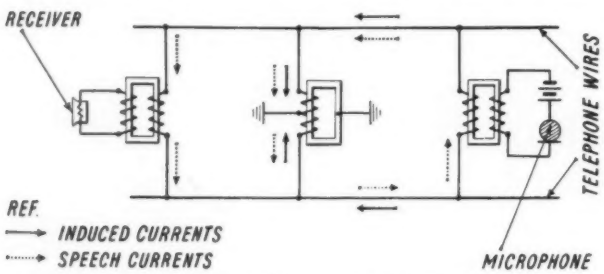


Fig. 1—Original arrangement of protecting coils

along the route, causing leakage between neighbouring wires, and a good deal of trouble was at first experienced with wire breakages in frosty weather.

When the railway was built not much was known about interference between single-phase traction wires and low voltage circuits nearby. In conformity with the prevailing ideas, the telephone and telegraph wires were erected on the transposition principle, provided with horn and spool-type lightning arresters and heavy and light current fuses. The best insulation possible was provided for the apparatus and all metal parts were earthed. Nevertheless, constant interference troubles were experienced. An induced voltage of 2,000 was created in the low voltage wires, and at times it was found impossible to carry on communication, which led to considerable inconvenience and delay to traffic.

In 1922 the line was taken over by the Austrian Federal Railways. More information was then available on the subject, largely due to the efforts of the Swedish State Railways, which had made a systematic investigation of the problem. The placing of the communication circuits in protected cables was recommended, but the cost of doing this was excessive in view of the diminished traffic caused by the alteration of frontiers, and cheaper ways of meeting the difficulty were sought. As the presence of the return wire and consequent compensation effect prevented the inductive action of the trolley circuit exceeding certain limits, it was decided to experiment with earthing coils, as shown in Fig. 1. These resemble in principle the impedance bonds used in track circuiting.

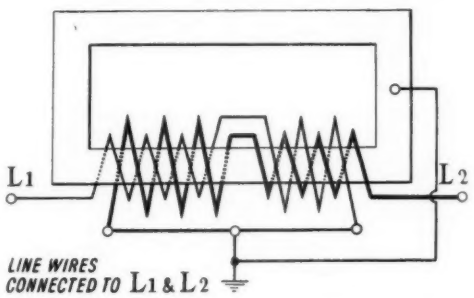


Fig. 2—Modified form of protecting coil

The number which can be used on a given length of circuit is limited, otherwise the telephone currents are unduly weakened. Unless the coils are absolutely symmetrical in every particular, disturbances are still liable to be created in the speaking circuit, and this actually occurred with the first coils tried. But the fundamental idea was correct, and further thought led to Siemens & Halske designing another pattern, wound as shown in Fig. 2. There are four windings in this case and the two telephone lines are connected at L1 and L2, so that each is connected to earth through an inner and an outer winding. These new coils were found to offer enough impedance to speech currents to enable several to be used, and by applying three to the whole line it was freed altogether from the disturbance due to the proximity of the 16 kV. wires. Each station-to-station telephone cir-

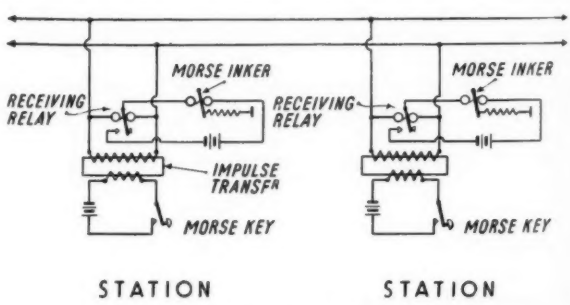


Fig. 3—Principle of impulse telegraph circuit

cuit was equipped with a coil and this enabled the circuits to be used without difficulty for communicating with the power station.

Although the telephone circuits were freed from disturbance in this way, difficulties still remained with the Morse telegraph circuit. The shield effect of the neighbouring telephone wires, now as good as earthed, was not effective enough and an induced voltage of 1,500 was

* From an article by Herr Biesok, Vienna, in *Zeitschrift für das gesamte Eisenbahn-Sicherungswesen.*

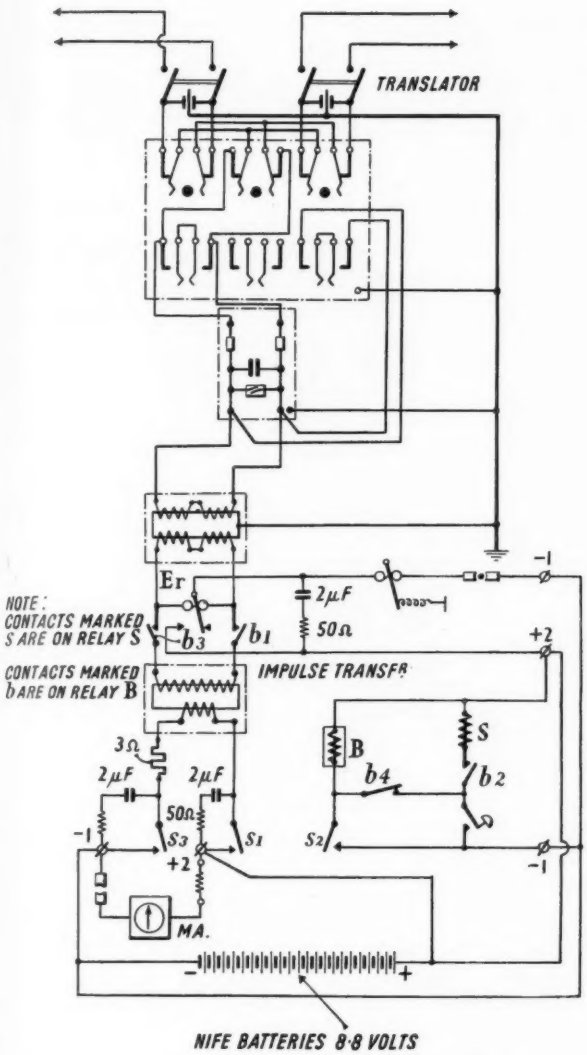


Fig. 4—Complete circuit arrangement for one station

found to exist. In 1929 Siemens & Halske developed a method of operating Morse apparatus over such wires which allowed the application of earthing coils. It afforded at the same time protection for the operators in the event of the high tension and telegraph wires coming in contact. As no previous experience was available a section of the station-to-station telephone circuit was converted and experiments were conducted on it with the new arrangement, which was ultimately adopted for the whole line.

Fig. 3 illustrates the general principle of the scheme. The Morse keys and inkers are retained but the former merely close a local circuit to the primary of a so-called impulse transformer. The secondary transmits an impulse to line when the key is depressed and a corresponding reverse impulse when it is released; these impulses are used to reverse polarised receiving relays at each station, the tongues of which control the local Morse inker circuits. Consequently when a key is depressed the line impulse momentarily created reverses the polarised relays and causes the inkers to mark until the key is released and the relays restored to the normal position by the reverse line impulse. Actually the circuits are rather more involved, and a complete station arrangement is shown in the diagram, Fig. 4.

The incoming lines are led to one winding of the translator with the object of forming a protection for the staff against high voltage currents. The other winding of the translator is connected to the secondary of the impulse transformer and the receiving relay is branched across this connection. Normally contacts on the relay B break the connection to the impulse transformer in order to allow the relay to receive the full value of incoming

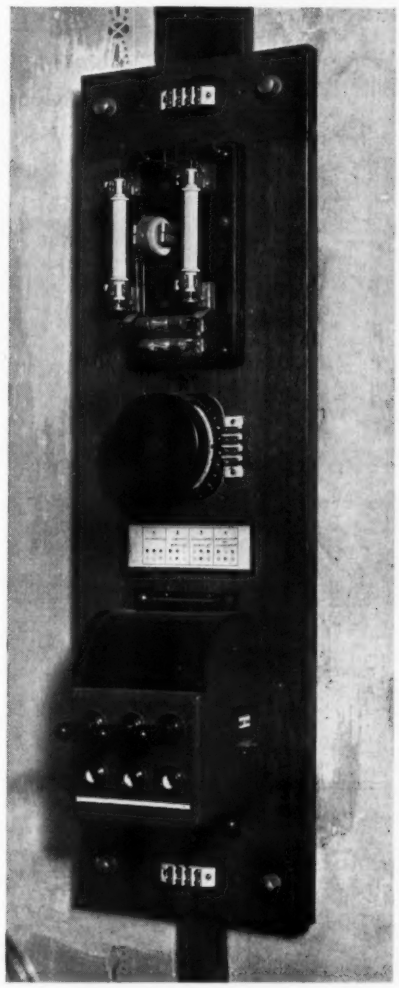


Fig. 5—Apparatus board

currents. These contacts have in consequence to be closed when sending takes place before the d.c. feed to the impulse transformer is established, and must not open until the impulse produced by the cessation of the current from the Morse key has ceased; otherwise the impulse would neither actuate the home relay nor reach the line circuit. The relay B is accordingly used to pick up a second relay S and is made slow-releasing.

The working is as follows. The depression of the key excites relay B, closing contacts b_1, b_3, b_2 and then opening b_4. Closing b_2 excites relay S and contact s_2 replaces the key in the circuit of B. Contacts s_1 and s_3 send current to the impulse transformer, whence an

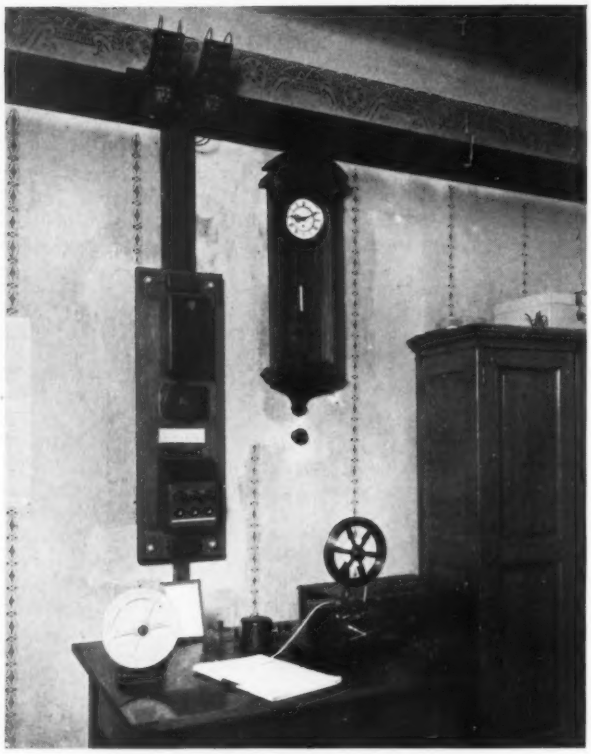


Fig. 6—Interior of telegraph office

impulse goes to the line over the translator. The home relay Er is reversed and likewise the corresponding relays at the other stations, bringing the Morse inkers into circuit. On the key being released S falls away and contacts s_1 and s_3 open the feed to the impulse transformer, causing a reverse induced impulse to be emitted which restores Er and the relays at the other stations, so that the inkers cease marking. The release of S also de-energises B, but the delayed action prevents contacts b_1 and b_3 opening before Er has been reversed. This interesting circuit arrangement has been used with satisfaction for three years.

At each station the line wires come in over isolating switches and heavy fuses to jack connection springs, which enable tests to be made and the line on either or both sides to be cut out as desired. The jack panel is seen at the bottom of the apparatus board in Fig. 5, with the translator in the middle and the fuses at the top, with cover removed. The special earthing coils, the use of which was rendered possible by this arrangement, are installed at the end stations as seen in Fig. 6, and the polarised relay, which is also used in the Siemens printing telegraph and selector telephones, is shown in Fig. 7.

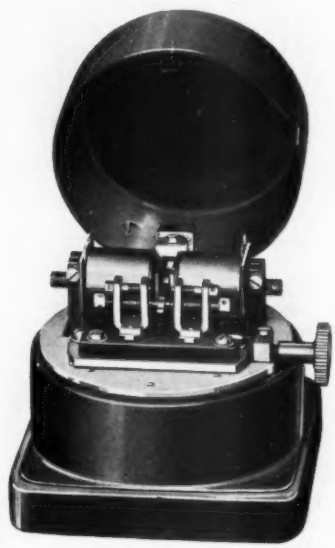
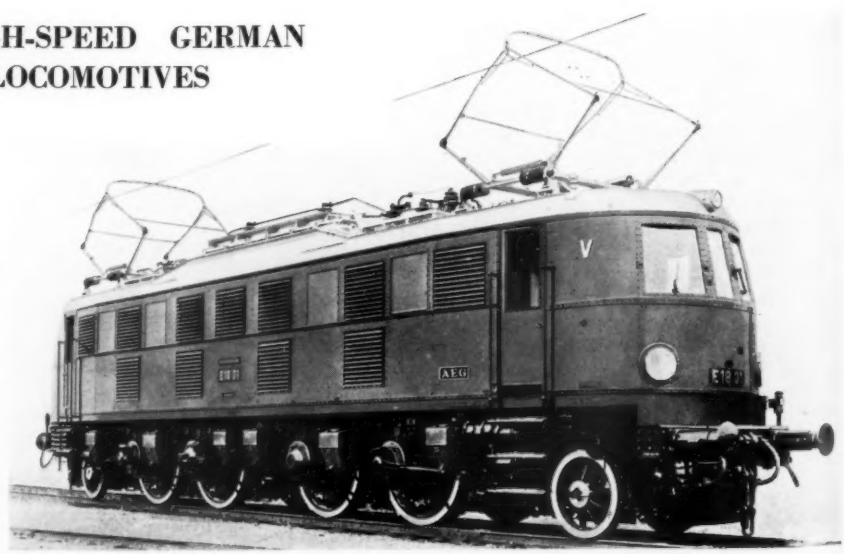


Fig. 7—High-speed polarised relay

HIGH-POWER HIGH-SPEED GERMAN ELECTRIC LOCOMOTIVES

Seventeen single-phase 1-Do-1 locomotives for a top service speed of 150 km.p.h. (93 m.p.h.) have been supplied to the Reichsbahn by the A.E.G. They scale 109 tonnes of which 80 tonnes rank as adhesion, and have a continuous output of 3,980 h.p. at 128 km.p.h. (80 m.p.h.) and an hourly rating of 4,230 h.p. at 122 km.p.h. (76 m.p.h.); the starting tractive effort is 21 tonnes (46,500 lb.). The Westinghouse-Kleinow type of individual axle drive is used. Although it was not thought necessary to adopt a fully streamlined contour, the locomotive has attained 102 m.p.h.